Cobalt, 1905.

SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY DEPARTMENT

OF

CANADA

FOR THE CALENDAR YEAR

1905

PRINTED BY ORDER OF PARLIAMENT

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EXCELLENT MAJESTY
1906

To His Excellency the Right Honourable Sir Albert Henry George, Earl Grey, Viscount Howick, Baron Grey of Howick, a Baronet, G. C. M. G., &c., &c., &c., Governor General of Canada.

MAY IT PLEASE YOUR EXCELLENCY,—

The undersigned has the honour to lay before Your Excellency, in compliance with 3 Vic., Chap. 2, Section 6, the Summary Report of the Operations of the Geological Survey Department for the calendar year ending December 31, 1905.

Respectfully submitted.

FRANK OLIVER,

Minister of the Interior.

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SUMMARY REPORT

OF THE

GEOLOGICAL SURVEY OF CANADA

FOR THE CALENDAR YEAR 1905.

The Honourable FRANK OLIVER, M.P.,
Minister of the Interior.

SIR,—The following report, which I have the honour to submit in conformity with the Act under which the Geological Survey is prosecuted, is intended to give a concise statement of the work which was performed by the department during the calendar year 1905. This work, both in the field and at headquarters in Ottawa, consisted entirely of original investigation and was directed primarily to increasing our knowledge of the mineral wealth of Canada. Our researches every year prove more and more conclusively that the mineral resources of this country are both great and varied and that they will constitute an important factor in the growth and prosperity of the Dominion.

While the discovery and making known of the mineral wealth of the country are the main objects aimed at, the work must be carried on in an intelligent and systematic manner, with a view to ultimately obtaining the greatest results. The reasons for some of our methods and operations may, therefore, not be at once understood by those unfamiliar with scientific pursuits.

One of the first things to be done is to ascertain and to show by maps, the distribution, on the ground, of the different rock formations. A certain useful mineral may be confined to one of these; different minerals may likewise be found in other formations, while other rocks again may carry nothing of economic value. The minerals peculiar to the various zones or different areas of rock may have certain peculiarities or signs as to their modes of occurrence. With a knowledge of these conditions, the prospector may confine his search within the area which alone can reward his labours, thus saving his time and affording him a better chance of success.

For the purpose of working out and defining the boundaries of the different rock-formations in unsurveyed or imperfectly known districts, it becomes necessary for the geologist, or his assistant, to make the indispensable topographical surveys. Again, in order to lay down this work properly on paper, a knowledge of mapping is requisite. Then, if we wish to connect together or show the relations of important geological areas, we sometimes require to make accurate astronomical observations, or to run lines of

survey where no rocks at all may be exposed, and, in fact, to take every means to secure all the data required for the construction of a good map. It might happen that geological lines, which are really nearly straight, if laid down on the basis of an inaccurate topographical map, would appear distorted, and vice versa.

As much as our field-work is now being done in unsurveyed and even unexplored regions, the most useful geologist is he who is also a good surveyor. Apart from the geological work which he performs, his service to geography is worth more than the cost of both. Owing to the fact that the topographical features everywhere depend upon the geological structure, the geologist becomes the best topographer.

In the last five years the maps which have been actually issued by the department amount to upwards of 150, while 27 more are almost finished and a considerable number are in various stages of drafting and engraving. When all these are issued, the number of separate maps produced in the above five years will amount to nearly half of the total since the commencement of the Survey in 1843.

GEOLOGICAL SOCIETY OF AMERICA.

On the invitation of the Logan Club, which consists of the technical officers of the Geological Survey, the Geological Society of America held its annual meeting for 1905 in Ottawa from the 26th to the 29th December. A number of valuable papers were read and the meeting proved successful.

INTERNATIONAL GEOLOGICAL COMMITTEE.

During its session the members of the central or parent International Geological Committee (Drs. C. Van Hise, C. W. Hayes, R. Bell and F. D. Adams) held a meeting and decided to continue field-work during the coming summer. The region selected for investigation and comparison was that covered by the Haliburton and Bancroft geological maps which have been already printed in colours, but not yet issued by the department, pending the completion of the reports upon this region by Drs. Adams and Barlow.

Drs. Adams and Bell, with the addition of Professor A. P. Coleman of the University of Toronto, were appointed as the Canadian members of the special committee for this work. They are to be joined by three other geologists representing the United States Geological Survey. After completing their work in Ontario the party will proceed to examine one or two districts in the State of New York for the purpose of correlating their geology with that of the above district in Ontario.

CONGRESS OF AMERICANISTS.

Two years ago, at the suggestion of the writer, the International Congress of Americanists, in session at Stuttgart, resolved to hold its next biennial meeting, that of 1906, in the city of Quebec, from the 10th to the 15th of August. A grant of $4,000 to assist in defraying the expenses of the meeting was obtained from the Dominion Government. A strong local committee is making all arrangements for the carrying out of the attractive programme which was decided upon.

Invitations were sent to the governments of all countries throughout the world requesting them to send delegates, and it is expected that a large number of learned men from foreign countries will honour us by their attendance. Numerous papers on important subjects to be read at the meeting have been already promised. The committee of organization consists of Dr. Robert Bell, F.R.S., president; Monsignor Laflamme, Dr. David Boyle and Dr. Franz Boas. The scientific programme being assured, it is hoped the meeting will prove a most agreeable and successful one.

CANADIAN COMMITTEE OF GEOLOGICAL NOMENCLATURE.

The committee on the nomenclature of geological formations in the Dominion, which had originated by the action of the Royal Society of Canada in 1901, has to a great extent been superseded by the more comprehensive international committee, and it did not hold any meeting last year. As it is very desirable that the geology of the two countries should be made to harmonize, it is felt that whatever might be found best for Canada should apply to the United States also, and therefore all the work should be left to the international committee.

FIELD WORK.

The field work, which is the foundation of all the progress made by the Geological Survey, was prosecuted with vigour. Thirty-seven parties, besides the Zinc Commission consisting of three members, went to the field. These were distributed all over the Dominion, from Peel river and the Yukon in the far northwest, to Nova Scotia in the southeast. In some instances the geologists went out alone or with one assistant, and hired temporary help when required; but in most cases they had several persons in their parties.

Most of the field work, as well as that at headquarters, was devoted to economic geology, but at the present time one of the principal duties of the Geological Survey is to produce as complete a geological map of the Dominion as possible, and as large areas still require to be explored for this purpose, a certain amount of energy must be given to this branch of our duties. Three well qualified new members have been added to the temporary staff during the year, namely, Mr. W. H. Collins, Mr. D. D. Cairnes and Mr. W. A. Johnston, all of whom did good field work during the past season.

The instructions given to the numerous field men were all successfully carried out, and although, in remote regions, the work is often difficult and sometimes hazardous, nothing happened to mar the good progress that was made. As in former years, a number of suitable men, not attached to this department, were engaged for field-work either on contract or on salary. The sequel has proved that all the field parties had been judiciously and advantageously placed and the results may be considered the maximum that could be expected. It is satisfactory to know that the work of the Survey during the year has met with the approval of all the important mining interests from the Yukon and British Columbia in the west to Nova Scotia in the east.

Last winter the Board of Trade of Rossland, B.C., asked for a 'structural geological survey' to be made of the Rossland group of mines, and Professor R. W. Brock was designated to undertake this work, assisted by Mr. W. H. Boyd, Dr. G. A. Young, a

lapidary and a draftsman. It is proposed to continue this work next year and perhaps longer, and when it is completed to publish a full report on the results. In the meantime Mr. Brock has prepared a preliminary report, which has been published. This report deals with petrographical matters, such as the composition and proper names of the rocks, with questions as to the origin of the ore deposits, the probability of their extension, and the possible discovery of other bodies of ore beyond the limits of those at present worked. The question of the probable depth to which the ores may extend is also discussed. The report likewise describes the methods of working at present employed.

At the request of those interested in mining zinc you appointed an independent commission to visit British Columbia and examine and report on all matters affecting the zinc interest. This commission, by your direction, received $7,500 out of the special grant of $19,000, which had been granted by special appropriation for the work of the Geological Survey in British Columbia and Yukon Territory during the year.

ARCTIC EXPLORATION.

In the summary report for 1904, Mr. Low's explorations of some of our northern coasts by means of the ss. *Neptune* were referred to. During the winter of 1904-5, this gentleman prepared a full report on this work, which was set in type in the spring and summer of 1905; a detailed map and a large number of fine illustrations were made for it. The book was being prepared as an edition de luxe, instead of as an ordinary blue book, under the name of 'The Cruise of the *Neptune*.' It was discovered, however, that Mr. Low, although a regular officer of the Geological Survey, had performed this work under a special commission direct from the Government, and that his report should therefore be published by the Department of Marine and Fisheries. The work is expected to be issued during the summer of 1906.

SUMMARY OF THE MINERAL PRODUCTION OF CANADA IN 1905.

Prepared by the Mines Section of the Geological Survey.

(Subject to Revision.)

Product.		Quantity. (a)	Value. (a)
METALLIC.			$
Copper (b)	Lbs.	47,597,502	7,420,451
Gold, Yukon	$8,327,200		
" all other	6,159,633		
		....	14,486,833
Iron ore (exports, estimated)	Tons.	116,779	125,119
*Pig iron from Canadian ore	"	70,554	1,047,860
Lead (c)	Lbs.	55,961,000	2,634,084
Nickel (d)	"	18,876,315	7,550,526
Silver (e)	Oz.	5,974,875	3,605,957
Cobalt		....	100,000
Other metallic products including zinc		....	180,000
Total metallic		....	37,150,830
NON-METALLIC.			
Asbestus	Short tons.	50,670	1,486,359
Asbestic	"	17,594	16,900
Chromite	"	8,575	93,301
Coal	"	8,775,933	17,658,615
Corundum	"	1,644	149,153
Feldspar	"	11,700	23,400
Graphite	"	541	17,032
Grindstones	"	5,172	57,200
Gypsum	"	435,789	581,543
Limestones for flux in iron furnaces	"	341,614	258,759
Manganese ore (exports)	"	22	1,720
Mica	"	....	168,043
Mineral pigments—			
Barytes	"	3,360	7,500
Ochres	"	5,105	34,675
Mineral water	"	....	100,000
Natural gas (g)		....	314,249
Petroleum (h)	Brls.	634,095	849,687
Phosphate	Tons.	1,300	8,425
Pyrites	"	32,774	123,574
Salt	"	45,370	310,858
Talc	"	500	1,800
Tripolite	"	200	3,600

The total production of pig iron in Canada in 1905 from Canadian and imported ores amounted to 527,932 short tons valued at $6,492,972, of which it is estimated 70,554 tons valued at $1,047,860 should be attributed to Canadian ore and 457,378 short tons valued at $5,445,112 to the ore imported.

(a.) Quantity or value of product marketed. The ton used is that of 2,000 lbs.
(b.) Copper contents of ore, matte, &c., at 15·590 cents per lb.
(c.) Lead contents of ore, &c., at 4·707 cents per lb.
(d.) Nickel contents of ore, matte, &c., at 40 cents per lb.
(e.) Silver contents of ore at 60·352 cents per oz.
(f.) Oven coke, all the production of Nova Scotia, British Columbia and the Northwest Territories.
(g.) Gross return from sale of gas.
(h.) Deduced from the amount paid in bounties and valued at $1 34 per barrel.

SUMMARY OF THE MINERAL PRODUCTION OF CANADA IN 1905.

(Subject to Revision).

Product.		Quantity. (a)	Value. (a)
Structural Materials and Clay Products.			$
Cement, natural rock	Brls.	14,184	10,274
" Portland	"	1,346,547	1,913,740
Flagstones			7,650
Granite			209,555
Sands and gravels (exports)	Tons.	366,935	152,805
Sewer pipe			382,000
Slate			21,568
Terra-cotta, fireproofing, etc			64,892
Building material, including bricks, building stone, lime, etc			6,095,000
Total structural materials and clay products			8,857,484
Total all other non-metallic			22,266,393
Total non-metallic			31.123.877
Total metallic			37,150.830
Estimated value of mineral products not returned			300,000
Total, 1905			68,574,707
1904, Total			60,073,897
1903 "			62,600,434
1902 "			63,885,999
1901 "			66,339,158
1900 "			64,618,268
1899 "			49,584,027
1898 "			38,697,021
1897 "			28,661,430
1896 "			22,584,513
1895 "			20,648,964
1894 "			19,931,158
1893 "			20,035,082
1892 "			16,623,417
1891 "			18,976,616
1890 "			16,763,353
1889 "			14,013,113
1888 "			12,518,894
1887 "			11,321,331
1886 "			10,221,255

Minerals Most Inquired For.

The following minerals alphabetically arranged, have been most inquired for during the year:—

Apatite,
Arsenical pyrites,
Asbestus,
Barytes,
Bauxite,
Blende, zinc,
Chrome iron,
Clays for hydraulic cement,
Clays for pottery, bricks, tiles, etc.,
Coal,
Cobalt,
Copper ores,
Corundum,
Feldspar,
Fire clay,
Fluorspar,
Gas, natural,
Gold,
Iron ores,
Ilmenite,
Kaolin,
Limestones for hydraulic cement,
Magnolite,
Marbles,
Mica,
Molybdenite,
Ochres,
Ozokerite,
Petroleum,
Pigments, mineral,
Pitchblende,
Platinum,
Pyrites, iron,
Quicksilver,
Shale, clay,
Silica,
Silver,
Slate,
Talc,
Tungsten,
Tripolite,
Vanadianite,
Witherite,
Zinc.

Petroleum and Natural Gas.

In the list of proposed bulletins given on another page, mention is made of one on Petroleum and Natural Gas. In last year's Summary Report a number of localities are given where petroleum is known to occur in British Columbia and the North-west Territories. The vast deposits of asphalt or tar-sand in the Athabaska region have been described in my report for 1882 and afterwards by Mr. R. G. McConnell.

In 1897 a boring in search of petroleum was made at the expense of the Geological Survey on the west side of the Athabaska river at Pelican rapids. At a depth of nearly a thousand feet, a flow of gas was struck, under high pressure. This prevented any further progress being made in deepening the bore hole. The gas has been blowing off with a roaring noise from the time it was tapped till the present day, a period of more than eight years. At the date of our latest information it is said to show no diminution of pressure.

During the last two seasons, searching for petroleum has been done on a large scale in the district drained by the Flat-head river in the southeastern corner of British Columbia and also in the adjacent tract in the southwestern corner of Alberta. In a number of localities in both these regions, seepages of petroleum have been known for some years. In April, 1905, Mr. Wm. Forest left with me a sample of remarkably good crude petroleum from Sage creek, a branch of Flat-head river.

Last summer a well which was being bored near Pincher Creek in southwestern Alberta close to the mountains was reported to have struck a great flow of oil, but this did not prove to be true. Another well was said to be in progress near Cardston, a short distance further east, but we have no information as to it. At Medicine Hat, gas continues to be obtained at a fair pressure by boring fresh holes in the vicinity of the original discovery.

During the summer of 1905, a boring in search of petroleum was sunk to a considerable depth on the Saskatchewan river under the management of Mr. Eugene Coste, M.E. He has encountered great difficulty in this undertaking on account of the soft and yielding nature of some of the strata passed through.

Last summer the search for petroleum on the eastern peninsula or large Indian Reserve of Manitoulin island was renewed by the Great Northern Oil and Gas Co., Limited, and it was said that a well two or three miles southwest of Wequemakong on the road to Manitowaning, had produced over 100 barrels of oil; also that smaller quantities had been obtained from several other experimental borings on the reserve.

In the southwestern part of the interlake peninsula of Ontario, new producing wells have been bored at several places not far from Leamington. These have been the means of perceptibly increasing the petroleum production of Ontario for the year.

It was proposed to bore for gas at Calgary, under the impression that the Medicine Hat horizon might be struck, but from the knowledge we have of the geology of the region around that town, this horizon is probably buried under a great depth of overlying strata.

The officers of the Survey best acquainted with the geology of this section of Alberta are Messrs. McConnell, Dowling and Cairnes. In regard to the prospect of finding gas by boring at or near Calgary, Mr. R. G. McConnell says the gas-bearing rocks of Langevin are buried at Calgary under several thousand feet of shales and sandstones. A very deep bore-hole would therefore be necessary to reach the horizon of the Langevin beds. No gas has yet been found in the Laramie formation. The crest of an anticlinal crossing the Indian Reserve, which is known to run in a southeasterly direction a few miles southwest of Calgary, would probably afford the most favourable points for boring; but the structure of the district is not well known.

Mr. D. B. Dowling says that two coal-bearing horizons exist, from which gas might come. At Langevin it rises from the lower coal-bearing strata of that locality. At Cassils gas may be found in shallow borings. The Pierre formation is generally composed of compact clays which would hold down any gas which might be escaping from the coals below it. The Laramie is a sandy formation and would not prevent the escape of gas. In the foot-hills the coals of Cassils, Lethbridge and Stair thin out very much. There is a great thickness of rocks at Calgary above the equivalents of the gas-bearing strata of Medicine Hat.

Mr. D. D. Cairnes says the gas of Medicine Hat, Langevin and Cassils comes from rocks of the Belly River Cretaceous series, which are deeply buried at Calgary. At Cassils gas has been struck above the horizon of that of Medicine Hat and Langevin. Near Calgary the best chance for finding gas would be somewhere along an anticlinal which runs S. 73° E. from a point two and a half miles due east of Cochrane street. At the shallowest depth, however, on this anticlinal, any gas which might exist would probably lie 700 to 800 feet deeper than that at Cassils. The next gas horizon would be 600 feet below this last. There is also a third horizon corresponding to the Tar Sands below the last mentioned. If boring be undertaken on the above anticlinal near Calgary, it should be at the lowest surface level. The most promising locality would

appear to be in the southwest corner of township 24, range 3 west of the 5th principal meridian, and section 2 or 10 may occupy the most likely position.

COLLECTIONS FOR EDUCATIONAL INSTITUTIONS.

The distribution of collections of Canadian minerals and rocks to educational institutions within the Dominion has been continued as in former years. Collections containing seventy-five specimens of minerals and twenty-five of rocks have been sent to collegiate institutes, high schools and academies, while collections of seventy-five good specimens of minerals, but of smaller size, were sent to schools of lower grades. More applications for these collections were received than could be filled. (They were sent first to those teachers who seemed to be the most enthusiastic and the best qualified to make good use of them.) In every case the recipients of the collections were required to agree to the following conditions: (1) That mineralogy or geology was being actually taught in the school. (2) That the collection was to become the property of the school itself and not of any officer who might be connected therewith. (3) That a suitable case or cabinet was to be provided for its safe keeping. The schools to which collections were sent are enumerated in Dr. Hoffmann's report in the present volume.

The above numbers of specimens are sufficient to cover all the minerals and rocks which the scholars are likely to encounter in nature, and it is as great as they can be expected to learn thoroughly. It was also thought that more good would be accomplished by sending out a large number of such collections, rather than a smaller number of collections containing more but rarer species. The time and money consumed in obtaining the material for these collections have also to be considered, the rarer minerals costing much more than the commoner ones.

CANADIAN ECONOMIC MINERALS AT THE LIEGE INTERNATIONAL EXHIBITION.

A good collection of the more prominent economic minerals of Canada was prepared for the Liege (Belgium) International Exhibition by Mr. R. L. Broadbent, an officer of the Geological Survey, for our Department of Agriculture. As at all previous international exhibitions, from that of London in 1857 to the one which has just been held at Liege, the Canadian collection of economic minerals took first place. In connexion with the last exhibition the following extract of a letter from Mr. Broadbent is of interest:—

LIEGE, (Belgium), November 21, 1905.

'Here Canada is the only country making a thoroughly representative mineral exhibit, and although we did not enter individual exhibits for awards we received a Grand prize for the collective exhibit. The jury expressed themselves as very much pleased with the extent and arrangement of the collection. We also had visits from the Mining and Geological Section of the International Congress of Mining and Metallurgy; the Congress of Geology; the Societé Belge Geologie, and others interested in mining and metallurgy, all of whom spoke in the highest terms of the exhibit.

'Belgium being the centre of one of the most important mining regions in Europe, our ores naturally attracted much attention, especially our lead and zinc ores. The largest zinc smelters in the world are here, the Vielle Montagne, and they told me that they would buy Canadian ore providing satisfactory rates could be arranged re shipping. With the C.P.R. direct communication with Antwerp, there ought to be a good market here for our ore.

'I also visited the smelting works at Stolberg, Germany. At these works they were using about 2,000 tons of Canadian (B.C.) silver-lead ore per month.

'In addition to the above ores, the inquiries for the most part have been in connexion with chrome, nickel, cobalt, asbestus, mica and corundum, the last mentioned, especially, attracting much attention. It has already a reputation in the European market as a high grade abrasive, and we have in our own section fifteen different exhibits of wheels, discs, &c., manufactured in the U.S., England, France, Germany and Belgium, all from Canadian corundum.'

HYDRAULIC CEMENT.

The manufacture of hydraulic cement, especially by the artificial combining of its ingredients is assuming large proportions in Canada. Numerous inquiries have come to the department during the year for pure limestones and good clays for cement making, especially from the west. Inquiries have also been received for stone which may be calcined and ground for hydraulic cement.

A very pure limestone is quarried near Kananaskis station on the line of the Canadian Pacific railway, on the northeast quarter of section 25, township 24, range 9, west of the 5th principal meridian, Province of Alberta. Its analysis is given on page 20, Part R, Annual Report, Vol. XI, 1898, being No. 695 of the publications of the Geological Survey.

A fairly pure limestone is quarried at the north end of Tunnel mountain in the Province of Alberta. Its analysis is also given on page 20 of the above mentioned Report R of Volume XI, 1898.

Materials for the manufacture of hydraulic cement can be obtained at Bulls Head Plateau, Cypress Hills. See page 786, Geological Survey Report for 1885. Shaganappi point, near Calgary, yields, when calcined, a cement of a very marked hydraulic character, setting under within from four to five minutes. See page 42, Report T, 1886.

The following references as to limestone and hydraulic cement stones mentioned in the reports of the Geological Survey may prove useful :—

Hydraulic Cement Stones.	Page.
Geology of Canada, 1863	804
Catalogue of Section 1, Geological Museum	128, 129
Annual Report for 1895, Part R, Good Hydraulic Limestone	16
" 1895, Part R, Good Hydraulic Limestone	21
" 1899, Part G, Analysis of Limestone	45
" 1899, Part R "	32, 33

Localities for Limestones and Cement Stones.		
Annual Report for 1887–88, Part R		109
" 1896	" S	159–60
" 1899	" S	122
" 1890–91	" D	42
" 1890–91	" E	39, 191, 198
" 1890–91	" E	63, 158, 172
" 1890–91	" E	176, 183
" 1890–91	" F	13, 54
" 1890–91	" L	33, 35, 41
" 1890–91	" A	38, 48, 58
" 1890–91	" P	16
" 1889	" R	24

UTILIZATION OF LOW-GRADE FUELS.

The invention of the Siemens' Regenerative Gas-furnace and of the improved gas producer engine has given a new value to low-grade bituminous coal, lignites and peat. The Siemens Brothers' producer furnishes the most successful method of applying gaseous fuel for the generation of power. Their patent, No. 167, British, 22nd January, 1861, was granted for 'improvements in furnaces.' The specification states that—'It is an essential part of our invention that the solid fuel used, such as coal, lignite, peat, &c., should be decomposed in a separate apparatus, so that the introduction of solid fuel into the furnace may be altogether avoided, and the gaseous fuel may be heated to a high degree prior to its entering into combustion with atmospheric air, also heated to a high degree, thus causing a great economy of fuel.'

In a paper read before the Canadian Mining Institute, Mr. Dowling says it has been found that the quantity of gas furnished by the lignite is greatly increased by adding an equal quantity of pulverized anthracite, as its fixed carbon 'cuts the tar' yielded by the producer method. Waste tar from any other source may be utilized along with anthracite dust or fine waste anthracite, or with crushed coke made into briquettes. A promising field for further experiments in order to obtain the best results from a variety of cheap materials, is offered in connexion with this process.

Bulletin No. 261 of the United States Geological Survey treats of this subject. Mr. W. R. Campbell, who has been, for two years, connected with the coal-testing plant of that Survey at St. Louis, wrote me in January, 1906, that they had been obtaining some very striking results in the way of the better utilization of low-grade bituminous coals and lignites and probably peat. The coal is converted into producer gas and is used directly in the explosive gas engine. By this method the efficiency of poor fuel is increased nearly or quite 100 per cent. He says: 'Strangely enough our most striking results are on the low-grade lignites of North Dakota and Montana. I presume similar results could be obtained on the same classes of fuel in Canada, and I sincerely hope that our investigations here may be utilized in the development of similar fuels in your country.'

This subject is discussed in Dr. Hoffmann's report in the annual volume of the Geological Survey of Canada for 1882-84. In 1903, Mr. D. B. Dowling of our Survey examined and reported on the lignite of the Souris River region in southern Saskatchewan, which may thus in future be turned to better account than might have been anticipated. These lignites form a continuation of those of North Dakota and Montana, referred to by Mr. Campbell.

METEORITES.

Mr. Robert A. A. Johnston, in addition to his field work in New Brunswick, has continued his studies of Canadian meteorites and has visited some of the localities where falls of these bodies have been reported. We have had casts made and coloured of all Canadian meteorites which are not in possession of the Survey. Mr. Johnston has nearly completed his report on this interesting subject and it will be issued as soon as possible.

Literature of the Geological Survey.

In the early years of the Survey the publications were not numerous, consisting principally of the annual Reports of Progress and a few maps, with an occasional special report. A few well illustrated Decades on Organic Remains were also published. In 1863 the late Sir W. E. Logan, the first director, issued a resumé of the first twenty year's work of the staff. This was a most useful book and it was intended to follow it by a similar resumé every twenty years thereafter, but forty-three years have since passed away and no further resumé has been written.

About this time there was a hiatus of five years when no Reports of Progress were published, after which their issue was resumed and continued to 1884 inclusive. In 1885 the name was changed to Annual Reports and sixteen volumes of these will have been completed with the issues now in press.

As there was necessarily more or less delay in getting out these full reports, on account of the preparation of maps, palæontological, chemical and other work required for them, it was felt that a preliminary account should be issued of the principal results obtained each year both in the field and at the headquarters of the Survey, together with a general statement as to all the affairs of the department; and to fill this want the publication was commenced in 1872 of an Annual Summary Report. With the growing extent and importance of the work of the Survey, these reports have been expanded year after year and they have been made to include some short complete reports where no further details are required and where it was very undesirable to keep back the information pending the issue of the large Annual Report.

In 1903, I commenced the publication of a series of Bulletins on Economic Minerals, to the progress of which further reference will be made. For some years back the Survey has also been publishing special reports on geological subjects, palæontology, zoology, botany, &c.

INDEX TO ANNUAL REPORTS.

In my Summary Report for 1904, I stated that it was proposed to compile a complete Index to the sixteen volumes of Annual Reports. Work on the Index to the Annual Reports was started by Mr. Frank Nicolas last year, and good progress has been made. The work, of course, involves a great amount of labour, and about 120,000 references have been already prepared. It is expected that the compilation will be completed by the end of this year and it is hoped the printing and binding will not take more than six months. This Index will be a most useful work and will greatly enhance the value of the sixteen large volumes of Annual Reports, which will then become available for easy reference.

The number of publications of the Survey distributed during the year 1905 amounted to 13,861.

After the issue of the Summary Report for last year, the press of Canada was invited to call attention to it and this was, no doubt, the means of making it known to large numbers, who might otherwise not have heard of its publication.

PUBLICATIONS IN 1905 AND 1906.

Summary Report of the Geological Survey of Canada for the calendar year 1904, pp. 392 (with 8 maps and other illustrations). Sessional document.

Report on the Klondike Gold Fields, Part B, Vol. XIV., pp. 71 (with three maps), by R. G. McConnell.

Annual Report of the Mines Section for 1903, Part S. Vol. XVI., pp. 156, by E. D. Ingall and J. McLeish.

Report on Recent Mineral Discoveries on Windy Arm, Tagish lake, Yukon, pp. 12, by R. G. McConnell.

The Mineral Pigments of Canada, pp. 39, by C. W. Willimott.

Geological Report on the Chibougamau Mining Region in the Northern part of the Province of Quebec, pp. 61 (with map), by A. P. Low.

Supplementary List of Publications, pp. 7.

Annual Reports, Vols. XIV. and XV. are in press.

The Annual Report of the Mines Section by Messrs. Ingall and McLeish, (Part S), for 1904 is ready for the press and will be published as soon as possible.

VOL. XIV.

A. Summary for 1901, by Dr. R. Bell.
B. Report on the Klondike Gold Fields, by R. G. McConnell.
F. Report on Ekwan river, Sutton lakes and W. of James Bay, by D. B. Dowling.
H. Report on Sudbury district, by A. Barlow.
J. Report on Perth sheet, by R. W. Ells.
O. Report on the Artesian wells of the Island of Montreal, by F. Adams.
S. Mines Section report, 1902.

VOL. XV. (IN THE BINDERY).

A. Summary for 1902 by R. Rell.
AA. " 1903 "
F. Report on the Souris Coal Fields, by D. B. Dowling.
S. Mines Section report, 1903.

VOL. XVI.

A. Summary for 1904, by R. Bell. (Published).
B. Report on Graham Island, by R. W. Ells. (Published).
C. " the Upper Stewart River region by J. Keele. (In preparation).
CC. " Peel river by C. Camsell. (In preparation).
G. " Yamaska Mountain, Que. by A. C. Young. (Published).
H. " Brome Mountain, Que. by Prof. Dresser. (Published).
S. Mines Section report, 1904. (Published).

BULLETINS.

A bulletin on The Mineral Pigments of Canada by Mr. C. W. Willimott was published during the year. Another bulletin on Barytes in Canada was prepared by Dr. H. S. Poole and is ready for the printer. Bulletins are in preparation and well advanced on The Clay Industries by Dr. Robert Chalmers, and on The Coal Mines of Canada by Theophile Denis.

FIELD-WORK.

As already stated, field-work was performed by no fewer than thirty-seven (37) officers, in addition to those acting on the Zinc Commission which consisted of three members, whose salaries and expenses were also paid out of the funds of the Geological Survey. The following is a list of the field parties of 1905, the objects they had in view and the regions in which they were employed, the latter being given in their order from northwest to southeast. Reports upon most of the work by the men in charge are contained in the following pages.

Mr. Charles Camsell, assisted by Mr. F. E. Camsell, surveyed Peel river, a large stream flowing northward in Mackenzie District. He started for Dawson from Skagway early in the spring before the ice broke up in the rivers and was ready to ascend the Stewart river as soon as it was clear of ice. He followed one of the northern branches of this stream in his canoes to a very long portage across the height-of-land separating it from the source of Wind river, a branch of the Peel. After descending the Peel nearly to the sea, he returned to the Bell river and Rat river, and thence descended the Porcupine to its junction with the Yukon. Here he was picked up by a steamer which took him up to Dawson and he returned in good time to Vancouver. It will be seen by his report that he accomplished a large amount of valuable topographical and geological work in this distant region. Mr. Joseph Keele also proceeded to Dawson before the breaking up of the ice and on the opening of navigation he ascended the Stewart river and continued his investigations of the gold-field on its northern headwaters, which had been commenced the previous year.

Mr. R. G. McConnell's operations were mostly in the district comprised by the headwaters of the White river, to the west of the Yukon. On his way home in the autumn, he made an examination of the recently discovered silver region of Windy Arm. Soon after his return to Ottawa he prepared a report on this district, which was immediately published under the name of 'Recent Mineral Discoveries on Windy Arm, Tagish Lake, Yukon Territory.'

Mr. F. H. Maclaren, who afterwards acted as Mr. McConnell's assistant, preceded him to the Yukon territory and made a survey from Whitehorse westward along the road to Kluane lake, triangulating the tops of the hills and mountains on either side.

Dr. R. W. Ells, assisted by Mr. Sydney Ells, made a geological reconnaisance of Graham island, the largest and most northern of the Queen Charlotte group. Dr. Ells circumnavigated the island and penetrated into the interior in a few places. While passing through British Columbia on his way west, Dr. Ells, accompanied by Dr. H. S. Poole, left the Canadian Pacific railway at Kamloops in order to revisit the coal field of the Nicola valley which he had examined the previous year.

While investigating the geology of Southern Alaska, under instructions from Professor Alfred H. Brooks, geologist in charge, Dr. Frederick E. Wright, of the United States Geological Survey, explored the Unuk river, which flows into Behm canal, opposite Prince of Wales island. Dr. Wright's work having been principally within British Columbia, the United States Survey has generously placed his results at our disposal, as if he had done this work for our department, and they are published as a short report in the present volume.

Mr. Theophile Denis, having been instructed to examine and report upon all the coal mines in the Dominion, visited those of Nova Scotia and afterwards those of the North-west provinces and British Columbia. His report on this work will be published as soon as possible.

Dr. Henry S. Poole, of Halifax, spent the summer in an investigation of the collieries and coal-bearing rocks of the Nanaimo coal field on the eastern side of Vancouver island, and has furnished an excellent report on the subject.

Mr. James M. Macoun, assisted by Mr. William Spreadborough, spent about four months, beginning in May, in continuation of his zoological and botanical work near the International Boundary (49th parallel) between British Columbia and the State of Washington. His field of operations this year was from Midway to Skaget river, the larger branches of which lie within British Columbia. After returning to Ottawa he spent the month of September collecting and studying the aquatic plants of the Ottawa district, in continuation of similar work done on Lake St. Peter the previous year. The latter part of the year was spent in determining and cataloguing the mammals, birds and plants collected during the last five seasons, along the southern boundary of British Columbia.

Professor R. W. Brock, assisted by Mr. W. H. Boyd and Mr. G. A. Young, as already stated, was engaged on a survey of the Rossland group of mines. His preliminary report on this work has been printed as a separate publication.

Mr. D. B. Dowling, assisted by Mr. Geo. S. Malloch, continued his investigations into the geology of the coal-bearing rocks of the Rocky mountains. His principal work the past season was along the Elm and Kananaskis rivers.

Mr. D. D. Cairnes, assisted by Mr. George S. Scott, was employed in an investigation of the geology of a large tract of country lying immediately to the east of the Rocky mountains and southward of the Canadian Pacific railway, which has been topographically surveyed and mapped by Mr. Arthur O. Wheeler, D.L.S. An additional tract, adjoining Mr. Wheeler's sheet to the south, was surveyed both topographically and geologically by Mr. Cairnes.

Mr. J. F. E. Johnston was instructed to proceed to the district around Edmonton, Alberta, in order to collect all possible data in reference to its geology, especially such as bear upon the occurrence of coal or lignite and on the possible existence of petroleum and natural gas in that part of the province.

Dr. Robert Chalmers made a reconnaissance examination of the surface deposits, especially of the clays, of all the more accessible districts throughout the provinces of

Manitoba, Saskatchewan and Alberta. He likewise visited a few places in British Columbia. He was also instructed to collect information of all kinds as to the superficial geology of the districts visited, with a view to further work on this subject in the future.

Mr. W. S. Dobbs was sent to the country lying immediately south of Cape Tatnam on the southwest side of Hudson Bay, proper. On his way to this region, he was to make track surveys of certain rivers, which had not previously been mapped by the Geological Survey. The reported nature of the country south of Cape Tatnam indicated a possibility of the existence there of a considerable tract of rocks older than the Silurian, such as those which occur southwest of Cape Henrietta Maria. In connexion with the construction of a geological map of Canada, it was important to settle this question.

Mr. Owen O'Sullivan, who had surveyed the whole western coast of James Bay in 1904, was instructed to continue this work on the southwestern coast of Hudson Bay lying between York Factory and Cape Henrietta Maria. He, however, succeeded in making a survey only as far as Severn river. Had he completed the projected work of the season, this would have finished the last link of the topographical survey by this department of the entire coast of our great inland sea.

Mr. William McInnes made a geological examination of a large tract around the head waters of the Attawapiskat and Winisk rivers, where it is believed that discoveries of economic minerals may be made.

Mr. W. H. Collins, assisted by Mr. H. C. Cooke made topographical and geological surveys in much of the country lying immediately north of Lake Superior between the Nipigon and Pie rivers.

Mr. W. J. Wilson commenced a regional geological survey of the area lying immediately north of the Sudbury and west of the Temagami sheet. He made good progress, but as the whole of this tract is in a state of nature, topographical surveys require to be made in order to lay down the geology, and probably two more seasons will be required to complete the work.

Dr. A. E. Barlow was instructed to make some more detailed geological examinations of Lake Temagami, for which a new map of the lake on a large scale, which had just been issued by the Ontario Government, would afford some assistance. He was also to continue the detailed geological work southward of the Eastern Arm of the lake, which had been commenced the year before by Dr. G. A. Young.

Mr. E. D. Ingall was engaged the greater part of the season in preparing reports of the Mines Section, but in the latter part of the summer, he proceeded to the Cobalt silver district, accompanied by Mr. J. A. Robert. These gentlemen inspected the district and made surveys of some parts of it.

Mr. C. F. King was employed in the early part of the season in surveying the line of the Temiscaming and Northern Ontario railway and afterwards in assisting Dr. Barlow.

Mr. A. F. Hunter continued the work of tracing the ancient shore lines of the northern part of the interlake peninsula of Ontario in the counties of Simcoe, Grey, Wellington and Bruce.

Professor T. L. Walker of Toronto University, assisted by Mr. R. E. Hore and Mr. Wm. Herridge, was occupied all summer in working out the geology of Muskoka district. Although good progress was made, the district is so extensive that another season will be required before a complete map of its geology can be produced.

Dr. J. W. Spencer, who had already devoted a number of years of his own time to elucidating some of the problems of the Great Lakes and the geological history of Niagara Falls and river, was employed all summer in completing his investigations of this history. The time seemed opportune for this work, on account of its great interest and the attention which it is attracting and also in relation to questions which are now prominent in connexion with the position of the International Boundary line at the Falls and as to the utilization of the cataract for generating power. Dr. Spencer's results are highly interesting and important.

Mr. W. A. Johnston, assisted by Mr. J. B. Tett finished working out the geology of the Peterborough sheet (Ontario) which represents the same area as the other Ontario sheets, namely 72 miles from east to west, by 48 from north to south.

Professor Ernest Haycock, assisted by Mr. Strong, continued to investigate the details of the geology of the Upper Laurentian rocks of a part of the counties of Labelle and Wright, on which he had been engaged the previous year, and it will require another season to complete the area it is proposed to map out.

Mr. C. W. Willimott devoted part of the season to the collection of minerals to be used in making up educational collections, and a part was required to exploit some new localities for a reddish brecciated limestone marble and also some varieties of greenish serpentine marbles. One of the former proved to be a sound and handsome stone, capable of a good polish, and it has been already used to decorate the main corridor of the House of Commons at Ottawa.

Mr. A. P. Low proceeded to Lake Chibougamau, northwest of Lake St. John in northern Quebec, where during the previous summer, Mr. J. Obalski, Inspector of Mines of the province of Quebec, had discovered asbestus of good quality and in considerable quantities, besides copper ore and a large quartz vein, holding small particles of free gold. These discoveries were referred to in my report for 1904 (page 33), where attention was also called to the fact that the late Mr. James Richardson of the Geological staff had found copper pyrites in the same neighbourhood in 1870. Mr. Low traced the distribution of the Huronian rocks, in which these minerals occur, for some distance to the westward of Chibougamau lake.

Prof. J. A. Dresser, who had in previous years worked out the geology of Orford and Brome mountains, devoted the past season to another of the Monteregian hills—Montarville mountain. He also made a collection of fossils from the shales around the base of the mountain, which comprises more species than had ever before been found in these rocks.

Professor John Macoun spent the summer months in collecting and cataloguing the plants of the north shore of the Lower St. Lawrence river. The other parts of the year were devoted to making a preliminary draft of a work on the mammals of Canada, in which much attention is given to their habits and distribution. Progress has been made towards completing a Flora of the Vicinity of Ottawa and the Flora of the Rocky Mountain Park, which latter is now nearly ready for the printer. Some attention has been given to the government museum at Banff, in this park, which is under the general supervision of the Geological Survey. Professor Macoun continues to add to his large stock of new information in regard to the Fungi, Lichens, Mosses, Algae and other cryptogamous plants of Canada, which have not yet been included in the published volumes of his Catalogue of Canadian Plants.

Mr. Lawrence M. Lambe spent some time on the north shore of Chaleur bay, in collecting fossil fishes from the Devonian rocks. By diligent search and by blasting the rocks, he secured a number of valuable specimens.

Professor W. A. Parks undertook some field work for the Survey in the western part of central New Brunswick, along the Nipisiguit river. In addition to this work, his petrographical studies of the specimens brought home are expected to throw some new light on the different problems of the geology of this part of the province.

Mr. Robert A. A. Johnston, assisted by Mr. Bronson, completed, as far as intended at present, the geology of Charlotte county, New Brunswick. His labours have been the means of improving very much the geological map of the southwestern part of the province.

Mr. Hugh Fletcher, assisted by Mr. A. T. McKinnon, spent the season at various localities along the Bay of Fundy side of Nova Scotia. Special attention was devoted to the examination and mapping of the iron ore bands of Nictaux and Torbrook.

Mr. E. R. Faribault was assisted in the field work by Messrs. James M. Cruikshank and A. Cameron, and in the map-making by Major F. O'Farrell. Their work lay mostly in the districts lying to the southwest of Halifax and consisted in a careful survey, so as to map on a large scale, all the features of each district, together with an accurate representation of the gold bearing quartz veins or leads.

My own field-work consisted partly of an inspection of the Klondike gold district and the collection of information as to the occurrence of coal or lignite in the Yukon Territory. Returning from this Territory, I visited Nanaimo coal field in order better to determine what further geological work was most needed in that region and how it might best be carried out. The mines of the various districts in the southern parts of British Columbia were visited and inspected underground as far as time would permit. I have to express my thanks to the officers of all the mines visited for their invariable courtesy and for affording me every facility for examining the mines themselves, the mining machinery and reduction works. At Fernie, I was indebted to Messrs. James McEvoy, W. W. Leach and H. Frechette, all of whom were formerly connected with the Geological Survey, for conducting me through the collieries and coking yards.

In November, I spent some days in looking over the mining and prospecting operations in the Cobalt silver district.

The work of the Survey at headquarters during the year has been vigorously carried on in all the branches. The accompanying reports by the various officers in charge are so full and explanatory that no further remarks are necessary.

The correspondence of the department continued to be large, but all letters were promptly and fully answered. We received, as usual, many questions and inquiries, relating to a variety of scientific subjects, besides those connected with geology, palæontology, mineralogy, mining, surveying, exploring, mapping; chemistry, metallurgy, archæology, botany, zoology, etc.; and all these were answered in due course.

HEAD WATERS OF WHITE RIVER.

Yukon.

Mr. R. G. McConnell.

Work was continued during the season of 1905 in the district about the head of White river. The time available for work in this distant region is somewhat brief as the summer is short and a considerable portion of it is occupied in travelling. On this account the examination of the district necessarily partook of the character of a reconnaissance. A topographic survey of the district was made by Mr. F. H. Maclaren, the topographer of the party.

Topography.

The region examined lies along the landward base of the St. Elias range, east of the Alaskan boundary, and is included in the drainage basin of White river, one of the principal western tributaries of the Yukon river.

The north eastern slope of the St. Elias range is largely drained by various branches of White river, the principal of which are the Kluane, Donjek and the Generk rivers. The trunk stream bends to the northwest and crosses the Alaskan boundary before reaching the mountains.

The Kluane river flows out of Kluane lake, a large sheet of water about forty miles in length, lying along the base of the St. Elias range, and fed mostly by Slims river, flowing from the Kaskawulsh glacier.

The Donjek is a typical glacial stream. Its muddy waters, flowing in numerous branching channels, spread out in seasons of flood across a bare gravel flood plain from one to three miles in width. The channels change continually, new ones being constantly opened, and old ones blocked, by the rapid, overloaded streams. Bars easily fordable at onehour are often impassable the next.

The Donjek appears to issue from a large glacier which occupies the whole width of its valley a few miles inside the mountains. I was informed, however, by a prospector who had explored its upper waters, that the glacier is fed by an ice stream descending a tributary valley from the northwest and that the upper portion of the main valley is free from ice and is partially wooded.

The Generk, though scarcely twelve miles in length, carries a large quantity of water and is one of the principal feeders of White river. It heads in the Klutlan glacier and flows northward parallel to, and a few miles east of, the Alaskan boundary. Like the Donjek, it has built up a wide gravel flood plain through which it winds in a multitude of interlacing channels.

The Klutlan glacier has a width, at present, of from two to four miles. It has evidently receded rapidly in recent years as it is bordered on the south by a wide belt of rough morainic country now free from ice. Its rate of motion is slow, and in places it appears to be stationary, as trees occur growing on shallow soil underlaid by clear blue ice. The lower portion and sides of the glacier are buried in debris. A ridge of fresh uncovered ice in the upper central portion of the glacier, only seen from a distance, suggests an active glacier over-riding an older almost stationary ice and gravel mass.

The St. Elias Alps, the principal topographic feature, form the southwest boundary of the district, and extend to the sea. The mountains and mountain ridges of this range are characterized by extreme boldness of outline. Steep slopes, precipitous cliffs and high broken peaks and crests prevail. The larger streams such as the Donjek and St. Clair have cut deep, wide valleys back into the heart of the range, while the smaller ones are usually inclosed in narrow steep-sided and often impassable cañons. The central portion of the range and all the higher mountains are covered with deep continuous snow fields, and glaciers—some of the first magnitude—are present everywhere.

The St. Elias range is bordered along its whole northeastern front by a wide continuous depression occupied in different portions of its length by a number of small streams. The depression is crossed transversely by all the large streams flowing from the range and evidently antedates by a long period the initiation of the present drainage system. The summit of the depression between Kluane river and the Donjek has an elevation of 1,500 feet above the former, and between the Donjek and the Generk of about 700 feet.

East of the depression is a broken upland cut by a system of interlocking valleys into mountain groups and ridges usually rising from three to four thousand feet above the valley flats. The mountains while rugged in places are more worn and are tamer in appearance than those in the St. Elias range, and their inferior height has also prevented the great accumulation of snow and ice which forms such a conspicuous feature of the latter.

FOREST.

The forest trees are few in number and include only the white and black spruces (*Picea alba* and *P. nigra*), the aspen (*Populus tremuloides*) and, occasionally, the balsam poplar (*Populus balsamifera*), and the birch (*Betula papyrifera*). The forest is sparse as a rule and ceases at an elevation of 4,000 feet above the sea.

GEOLOGY.

The geology of the district proved less interesting than was expected, as the older rocks along most of the St. Elias range and for some distance eastward, are buried beneath a great thickness of comparatively recent effusive and fragmental volcanics.

Tertiary.

A band of rocks referred to the Tertiary follows the St. Elias range from the Duke river to the St. Clair. They are well exposed on a small stream which enters the Donjek from the west a mile above the mouth of Wade creek. They consist here mostly of grayish conglomerates often only slightly indurated, formed of smooth and well rolled pebbles of quartz, quartzite, slate, chert and diorite. A band of red, iron-stained conglomerate occurs at the base of the formation, derived mostly from the debris of underlying dioritic rocks. With the conglomerate are beds of grayish and yellowish tufaceous sandstones, dark, often carbonaceous shales, and occasional beds of lignite.

The conglomerates and associated clastic beds of the Tertiary alternate with numerous lava sheets from fifteen to one hundred feet in thickness which appear to be contemporaneous with them. The lava sheets are usually andesitic in character and, in places, are slightly vesicular. They have smooth surfaces and decrease in thickness gradually towards their termination. They conform perfectly with the inclosing clastic beds even when the latter are steeply tilted. No dikes connecting with sheets were observed. The vulcanism which accompanied the deposition of the Tertiary beds was of long duration, as the latter are overlaid by at least 4,000 feet of effusive and fragmental volcanic rocks.

The Tertiary beds which outcrop along Maple creek consist mostly of shales and sandstone with some conglomerate and an occasional lignite seam. On Granite creek and east of the St. Clair river conglomerate is the principal constituent of the formation.

The Tertiary beds are strongly folded in places, especially near the mountains, and therefore antedate in age the last movements which produced the St. Elias range. No determinable fossils were obtained from them.

Mesozoic Beds.

The mountains of the St. Elias range fronting on Kluane lake are largely built of hard greenish tufaceous beds alternating with dark shales, breccias and, occasionally, agglomerates. Similar rocks outcrop at the cañon of Duke creek and also at the lower cañon of Burwash creek. The beds of this series, as a rule, are sharply folded and, in places, are overturned and broken. The rocks, usually hard, are more or less altered, and occasionally pass into green chloritic schists.

Specimens of the Triassic fossil *monotis subcircularis*, were obtained from a band of dark shales outcropping near the centre of the lower cañon of Burwash creek. It is unlikely that the whole series is referable to one period as, in places, it is many thousands of feet in thickness. It probably represents the product of repeated volcanic outbursts, possibly continued into the Tertiary.

Upper Palaeozoic.

The rocks referred to the upper Palaeozoic consist mostly of massive limestones and marbles associated with hard shales and slates and feldspathic sandstones. A good section of these rocks is displayed along the Donjek valley from the point where it leaves the St. Elias range up to the Donjek glacier, a distance of about seven miles. The outer range at this point is built of diorite. The diorite is followed by a wide band of crushed, reddish weathering limestone underlaid by grayish massive limestones and alternating limestones and shales. The latter are succeeded by feldspathic sandstones and limestones, both holding fossils of Carboniferous age. The tufaceous beds are cut by diorite, above which is a second band of massive gray limestone, followed by dark slates, altered in places into a schist. The slates are succeeded by reddish granites and diorites.

The limestones and associated rocks strike in a northwesterly direction and dip uniformly to the northeast at angles of from 30° to 70°. This outward dip is unusual in the great mountain ranges of the west, and is not a constant feature of the St. Elias range, although it occurs at several points.

At the head of Burwash creek the outer range of the St. Elias mountains is built of massive limestone, and bands of limestones and shales similar to those on the Donjek but dipping at a high angle in the opposite direction. North of the limestones—and apparently underlying them—are hard feldspathic quartzites, dark shales and iron-stained tufaceous beds. These beds have a nearly vertical attitude and their age relationship to the limestones is uncertain.

The mountain groups northeast of the trail from Burwash creek to the Donjek are built largely of slates, hard tufaceous rocks and limestones similar to those in the St. Elias range. West of the Donjek the limestones disappear and the rocks outcropping along the valleys of Wolverine and Harris creeks consist mostly of hard, imperfectly cleaved slates and tuffs, cut by numerous diorite dikes and by a granite area.

The rough grouping of the clastic rocks of the district into the three series briefly described above is only intended as a provisional one and will doubtless be greatly modified when the region is examined in detail.

Massive Igneous Rocks.

Andesites and Basalts.

Effusive rocks have a wide distribution in the district. A large area commencing within a few miles of Kluane lake crosses Duke river valley and extends northward to the 'gap' of this stream. A second small area—probably a disconnected portion of the first—occurs south of upper Burwash creek. Between the Donjek and the Generk the mountains of the St. Elias range, and a wide flanking plateau, are built entirely of these rocks and they extend westward across the Generk to the Alaskan boundary.

The effusives rest on the Tertiary north of the Donjek and are therefore the youngest rocks in the district. The lava sheets in the Duke river area are nearly

horizontal and show no signs of disturbance. North of the Donjek the sheets are often sharply bent and in places are broken and faulted.

The effusives in this series consist mainly of augite andesites of a somewhat basic type, and basalts. The sheets range in thickness from a few feet to several hundred feet, and are usually separated by tufaceous beds varying in texture from a fine ash to a coarse breccia. The series has a minium thickness of 5,000 feet.

Amygdaloids.

Bands of a green amygdaloidal rock occur at several points in the district, usually associated with the Mesozoic tufaceous beds. The upper portion of the lower cañon of Burwash creek is cut through this rock, and it was also found at the upper cañon of Tatamagouche creek and on one of the creeks flowing into Kluane lake. It is important as it is supposed to be the source of the native copper which occurs loose in so many of the creeks of the district. Lithologically it is a vesicular diabase. The augite in the section examined is mostly altered to chlorite, and the cavities are filled with calcite usually surrounded by a ring of chlorite. A similar rock—also associated with copper deposits—occurs in the Windy Arm district.

Gabbro-diorite.

This is a dark gray rather fine textured intrusive, widely distributed in stocks and dikes throughout the district. It is a hard rock and in the St. Elias range usually weathers into high bold peaks. It cuts the beds of the Mesozoic series but is older than those referred to the Tertiary. While usually massive it is slightly sheared in places and is occasionally seamed with small quartz veins.

The mineral constituents of the gabbro-diorite exhibit considerable variety in different sections. In places the rock is a typical diorite consisting essentially of hornblende, some biotite, and labradorite. This type passes by the substitution of augite for hornblende into a gabbroic variety, and by the addition of quartz and microperthite into a grano-diorite.

Quartz Porphyrite.

A yellowish porphyritic rock showing, in thin sections, a fine grained quartz and feldspar base, through which crystals of a plagioclase feldspar, biotite and quartz, are porphyritically distributed, outcrops in considerable masses along Burwash creek. It is probably the youngest intrusive on the creek.

Dunite.

Areas of dunite, partially altered in places into serpentine, occur on Burwash creek and on a branch of Quill creek

ECONOMIC GEOLOGY.

Coarse gold occurs in nearly all the streams in the district except those flowing over the recent volcanic rock, but no rich concentrations have so far been found. Brief descriptions of all the creeks worked, with the exception of Arch creek, are given in the

Summary Report of 1904 and need not be repeated here. Ruby creek, the centre of mining operations in 1904, is now almost abandoned and the miners have moved on to Fourth-of-July creek, a parallel stream flowing out of the same range. A few claims are being worked on Fourth-of-July below the mouth of Snyder creek. A feature of the workings of this creek is that the auriferous gravels rest on a band of boulder clay which constitutes the bed rock. The boulder clay band has not been pierced, and there is a possibility—as pointed out in last year's Summary—that pay-gravels may exist beneath it. The gravel bed overlying the boulder clay is shallow and easily mined, but carries comparatively light values.

A large amount of work was done on Bullion creek by the Bullion Hydraulic Co. This company has taken over most of the ground below the cañon and spent the season in installing a hydraulic plant. A flume five feet by three and a half feet, with intake on claim No. 26, has been built down the valley to claim No. 48, a distance of about a mile. In places where the valley slopes were favourable the flume is replaced by short ditches. The grade of the creek is steep and a head of 175 feet is gained in this distance. The water is supplied to the monitor through a pipe 1200 feet in length and thirty-six inches in diameter at the intake. At the time of my visit excavations for a bed rock flume were in progress. The monitor was employed for this purpose and appeared to be doing very efficient work. Preparations were not completed in time to admit of a satisfactory test of the creek before the season closed.

A number of claims were worked on Burwash creek throughout the season, both above and below the cañon, with varying results. The values in the upper part of the creek have proved generally unsatisfactory and some of the claims have been abandoned. A stretch of fair ground several claims in length has been found in the valley about a mile above the cañon and a second one at the foot of the cañon. The returns from the best claims seldom exceed ten dollars per day per man. Mining on Burwash creek is attended with peculiar difficulties: the creek is subject to sudden floods and on several occasions last season wing dams and drains—the result of weeks of hard work—were destroyed by the rushing waters in a few minutes.

Some prospecting has been done on Tatamagouche creek, a northern branch of Burwash creek. This creek is similar in character to Burwash creek and cuts the same rocks. It enters Burwash creek through a long cañon above which the valley is wide and open.

Further to the west is Arch creek, the latest discovery in the district. This stream heads with a branch of Quill creek and flows westward into the Donjek. Its grade averages about 300 feet to the mile. Like most of the creeks of the district the valley contracts at one point into a narrow cañon. The cañon is situated about a mile above the mouth of the valley and is about three quarters of a mile in length. Half a mile above it is a second small cañon 200 yards in length, above which the valley widens out and is bottomed with narrow flats and bordered in places with terraced slopes.

The rocks outcropping along the valley consist of hard tuffs, slates and limestones cut by several small diorite masses. The name of the creek is derived from an arch like opening in a band of limestone crossing the cañon through which the stream has cut

a passage. The slates and tuffs are traversed by small quartz veins from which the gold in the creek has probably been derived.

At the time of my visit a few claims were being worked in the cañon, where the gravels are comparatively shallow. In the upper part of the valley the gravels deepen, and the few holes sunk have failed to reach bed rock. The gold obtained is found on or near bed rock, and consists mostly of heavy grains and small nuggets. The largest nugget found was obtained from No. 9 claim in the cañon, and weighed over three ounces. It contained considerable quartz, and its rough surface showed that it had not travelled far. No ground yielding more than good wages has been found on the creek up to the present.

It is somewhat remarkable considering the number of creeks in the district on which coarse gold has been found, and the wide area over which they are distributed, that occasional rich concentrations have not been found. The chances of such discoveries are, of course, not by any means exhausted, as none of the creeks have been fully prospected, and some of them have scarcely been touched, and it is this which keeps the miner in the field. The present yield of the best claims of from \$6 to \$10 per day can hardly be considered wages in a region where the cost of supplies is so excessive and the working season is so short and broken.

COPPER.

Native copper is almost as widely distributed in the creeks of the district as gold. It is found on Bullion, Sheep and other creeks flowing from the St. Elias range, and also on Burwash, Tatamagouche and Arch creeks, in the region between Kluane river and the Donjek. It is not found on Ruby, Fourth-of-July, or any of the streams cutting the old schists of the Ruby range.

The principal copper creek in the White River district is Kletsan creek. This stream is situated in Alaska, about four miles west of the International Boundary. It was examined by Mr. A. H. Brooks of the U. S. Geological Survey in 1898. Brooks found that the stream copper, in part at least, was derived from calcite veins cutting a dioritic rock exposed along the valley. These copper-bearing rocks do not extend far in an easterly direction, as they are soon buried beneath a great accumulation of young volcanic rocks.

Areas of a dioritic rock apparently similar to that on Kletsan creek occur on most of the copper-bearing creeks in the Kluane district, but no mineral discoveries have so far been made in them.

The upper part of Burwash Creek cañon is cut through a green, often iron stained, diabase amygdaloid. This rock is cut by a few small calcite veins, which are usually stained with copper and carry small quantities of chalcopyrite and occasional grains of native copper. Similar copper-stained amygdaloids occur on Tatamagouche and several other creeks in the district. No veins of commercial importance have been found in them up to the present.

ATIVE SILVER.

Occasional coarse grains and small rough nuggets of native silver occur with the gold on Burwash and Arch creeks.

COAL.

Lignite coal of good quality occurs throughout the Tertiary area extending along the foot of the St. Elias range from the Donjek to the St. Clair. The veins vary in thickness from a few inches up to four feet.

WINDY ARM DISTRICT, NORTHWESTERN BRITISH COLUMBIA.

Mr. R. G. McConnell.

On the way back from the White River country a few days were spent late in the season examining the recent mineral discoveries on Windy Arm, Tagish lake.

SITUATION AND COMMUNICATIONS.

The principal ore deposits so far discovered in this district occur on the west side of Windy Arm, a southerly branch of Lake Tagish. Tagish lake forms part of a chain of long narrow lakes, including, in order from north to south, Lakes Lindeman, Bennett, Nares, Tagish and Marsh, which commence well within the Coast range of mountains and extend northward and eastward for a distance of nearly seventy miles. The general direction of these lakes is north and south, with the exception of Lake Nares and the upper part of Tagish lake, which have an east and west alignment. Windy Arm joins Tagish lake near its head and extends south for a distance of twelve miles. Its course is nearly parallel to that of Bennett lake, and the two sheets of water inclose an area of high mountainous country about eight miles in width, the scene of the principal recent discoveries.

The White Pass and Yukon Railway affords easy communication to the new mining district. This line, after crossing the Coast range, follows the east shore of Bennett Lake to Caribou Crossing, at the foot of the lake, at which point steamers run to Conrad City, on Windy Arm, the shipping point of the mines. The total distance from tide water at Skagway to Conrad City is 79 miles, of which 67·5 miles is made at present by rail and 11·5 miles by water. A railway can easily be built from Caribou Crossing along the shores of Lake Nares, Tagish lake and Windy Arm to Conrad City, and surveys for one have already been made by the engineers of the White Pass and Yukon Railway. A second route from Log Cabin station, on the main line of the White Pass and Yukon Railway, above Bennett lake, by way of Tutshi lake to Windy Arm, has also been proposed. The distance to tide water would be reduced considerably by this route, but the mileage of new line necessary would be greater.

CHARACTER OF COUNTRY.

The country bordering the northeastern slope of the Coast range, including the Windy Arm mining district, may be characterized generally as consisting of a system of wide valleys, often interlocking in a peculiar manner, separated by mountain groups and ridges rising from 4,000 to 5,000 feet above the valley flats. Most of the valleys are bottomed at intervals with long narrow deep lakes, due to the blocking of the channel at various points with glacial drift. The uplands are usually fairly regular in outline, but in places are exceedingly rugged and are often deeply incised by the numerous small streams which flow down their sides.

The forest growth is sparse and is confined to the valley flats and lower slopes of the mountains. At an elevation of 2,000 feet above the valley bottoms the forest practically ceases. The principal trees in the district are the white and black spruces, the aspen, the balsam poplar, the balsam fir and the black pine. The supply of rough lumber within easy distance of the camp suitable for ordinary mining purposes is ample for some years at least.

GEOLOGY.

The mineralized area on Windy Arm is situated a few miles northeast of the long granite batholith of the Coast range. This great igneous mass extends from the southern boundary of British Columbia in a northwestern direction to latitude 62 north, a distance of fully 1,000 miles, and constitutes one of the largest continuous granite areas in the world. Mineralized areas have been found at a number of points in both the older clastic and younger intrusive rocks, flanking the Coast range batholith, and it is probable that further discoveries will be made, as the adjoining country, especially on the landward side of the range, has so far been only imperfectly prospected.

The clastic rocks flanking the Coast range granite in the vicinity of Bennett and Tagish lakes, consist of crystalline limestones, coarse slates passing in places into schists and interbanded with quartzites, limestones and hard, fine grained cherty beds, and dark argillites alternating with tufaceous sandstones, coarse conglomerates, and occasional limestone bands.

A section from Tagish lake up Windy Arm and along the short valley connecting Windy Arm with Tutshi lake was studied in some detail. Near the mouth of Windy Arm the rocks consist of light grayish heavily bedded crystalline limestone, striking in a northwesterly direction. These rocks have an extensive development along the south-eastern shore of Tagish lake and the lower part of Taku Arm. They also extend in a wide band from a point near the west end of Tagish lake southeastward to Atlin lake.

The limestones are succeeded going south along Windy Arm by a set of beds which will be referred to as the Tagish series. This series consists largely of dark, hard argillaceous rocks, coarsely bedded and occasionally passing into impure quartzites. The slates are interbanded in places with crystalline limestones and also include numerous beds and bands of fine grained compact cherty rocks, probably hardened by

the infiltration of siliceous waters. Occasional bands of amygdaloid are also present. The relationship of the Tagish series to the crystalline limestone was not ascertained. The latter is probably Carboniferous in age.

The Tagish series is replaced ascending Windy Arm by basic igneous rocks usually porphyritic in character. The porphyrites and associated rocks outcrop along the shores of the lake for a distance of five miles and are then succeeded by a series of clastic rocks for which the name Tutshi series is proposed. The Tutshi series consists mostly of dark well cleaved argillites, softer and less altered than those in the Tagish series. The argillites alternate in places with fine grained tufaceous sandstones and occasional beds of grayish limestone. Bands of conglomerate and agglomerate also occur in this formation, the former holding well rounded pebbles of slate, quartzites and granite. The Tutshi series resembles lithologically a formation in the Atlin district, holding fossils supposed to be of Jurassic age (Part B. Annual Report Geological Survey of Canada Volume 12, 1899, page 26).

A parallel section along the lower part of Bennett lake cuts the same formations as those exposed on Windy Arm, except that the Tagish series is partly replaced by an outlying granite area. The northeastern boundary of the main Coast range granite mass crosses Lake Bennett at Pavey station, five miles below the head of the lake.

The massive igneous rocks of the district consist of granites and porphyrites and allied rocks.

A granite area about three miles in width occurs at the lower end of Bennett lake, and strikes southward towards the head of the south branch of Montana creek. The granite is a medium grained unsheared gray rock consisting of quartz, orthoclase, oligoclase biotite and hornblende. Dikes of a similar character cut the Tagish series on Windy Arm.

The porphyrite is the most important rock, economically, in the district, as most of the veins discovered up to the present occur in it. It crosses from Windy Arm to Bennett lake in a band from three to five miles in width, and also extends for some distance east of Windy Arm. It is a dark grayish, usually rather fine grained rock, distinctly porphyritic as a rule. Thin sections show feldspar phœnocrysts scattered through a crystalline base, consisting mostly of small feldspar crystals and chlorite. Augite is occasionally present, and calcite is abundant in the sections examined. In many places the porphyrite is heavily charged with iron, and weathers to a rusty colour. At Red Deer mountain it either passes into, or is replaced by, a medium grained rock with the character and composition of gabbro.

The principal structural feature of the porphyrite-gabbro are the systems of strong jointage planes everywhere present. The joints, like the veins, show little parallelism in either dip or strike in different parts of the area.

GENERAL CHARACTER OF VEINS.

The largest and most persistent veins so far discovered occur in the porphyrite area. They are not, however, confined to this formation, a few occurring in the granite and

some, also, in the slates The veins occupy typical clean-cut fissures with regular walls often slickensided and grooved. They are comparatively narrow but as a rule exhibit remarkable persistency in strike. The Uranus vein, with a width of from one to four feet, has been traced by small openings and surface showings for a distance of about 1,500 feet and may extend much farther, while the Montana vein, with a maximum width of five feet in the portion explored, has apparently been cut at a distance of 1,600 feet from the main workings and may also, of course, be very much longer. The Venus No. 2 lead (the largest seen by the writer) has a width of nine feet at two openings about 400 feet apart, and must extend for long distances in both directions. Numerous other veins such as the M. and M., the Joe Petty and Venus No. 1 are traceable by surface outcrops for several hundred feet. Portions of all these veins are concealed by slide rocks, and their full length was not ascertained.

The dip and strike of the veins are exceedingly irregular. The Montana vein strikes N. 43 W., while the direction of Venus No. 2 is about N. 42 E. The M. and M. strikes nearly north and south. The dips are nearly all to the south and west and vary in steepness from 12° in the Montana to 50° in Venus No. 1.

The gangue in all the veins is mainly quartz. Single and multiple lines of interlocking quartz crystals are a constant feature. In a few instances, portions of the vein-filling consist of alternating layers of quartz and country rock. The latter, in such cases, is always heavily mineralized, usually with iron, and weathers to a rusty colour.

The list of metallic minerals contained in the veins as identified in the field, and in the laboratory of the Survey from specimens brought back by the writer, includes the following :—

Native Silver.—Occurs in small spangles and in wire form in the Montana and Uranus veins.

Argentite.—Is found in some of the veins but is not abundant.

Stephanite.—Occurs in several of the veins and is an important source of silver.

Freibergite.—A dark, highly argentiferous mineral occurring in some abundance in the Joe Petty, Montana, and some of the other claims has been referred tentatively to this species. A partial analysis by Mr. Connor showed it to contain copper, silver, zinc, arsenic, iron, sulphur and antimony, the constituents of freibergite. The copper percentage in the specimen examined amounted to 9 per cent and the silver to 37 per cent.

Pyrargyrite (Ruby Silver).—This rich silver mineral occurs in most of the veins, sometimes in considerable quantity.

Galena.—This mineral occurs in all the veins and is usually highly argentiferous.

Tetrahedrite.—Argentiferous tetrahedrite occurs in small quantities in the Montana, M. and M., and probably in other claims.

Chalcopyrite.—Occurs in the Silver Cliff and other claims east of Windy Arm.

Native Copper.—Occurs in the Millet, Fedora and other claims east of Windy Arm.

Malachite and Azurite.—Green and blue incrustations and stains referable to the copper carbonates and due to the leaching out of the copper in the tetrahedrite and freibergite occur in most of the veins.

Specimens of a green mineral stated to be a silver chloride proved on examination to be a copper carbonate. It is possible that such a chloride is present in some of the veins but it could not be detected in the specimens examined.

Iron Pyrite.—Common in all the veins.

Arsenopyrite.—Occurs in a number of the veins but is usually subordinate in quantity to the iron pyrite.

Pyrrhotite.—Occurs in the Big Thing group.

Sphalerite.—Zinc-blende occurs sparingly in most of the veins examined.

MINING DEVELOPMENT.

Montana.—This important vein is situated on a bleak hillside about 3,700 feet above Windy Arm and 5,860 feet above the sea. An aerial tramway, four miles in length, connecting it with Conrad City, on the lake shore, was nearly completed at the time of my visit. At present, all supplies and materials for the mine, including firewood, are packed on horses.

The principal workings consist of a drift 180 feet in length. The drift pierces 50 feet of slide rock, then meets and follows the vein. A small fault, with a displacement of seven feet, was encountered at one point. The strike of the vein is N. 43 W., and the dip 10 to 12 to the S.W. The width of the vein increases from about two feet near the mouth of the drift to nearly five feet at the face. Some stoping has been done and a considerable quantity of ore has been shipped.

The ore minerals include native silver, pyrargyrite, argentite, freibergite (?), tetrahedrite, galena, and iron and arsenical pyrites. The distribution of the minerals through the quartz gangue is somewhat irregular. In places, especially near the walls, the vein matter is so thoroughly impregnated with silver bearing minerals that it is rich enough to ship without much sorting—that is, it contains values of $80 per ton and over. The leaner portion of the vein will require concentration.

The principal values in the vein are in silver. The ferruginous portion of the vein is stated to also carry some values in gold.

At the time of my visit a second drift, intended to cut the Montana vein at a distance of 1,600 feet in a northwesterly direction from the main workings, was being driven, mostly through slide rock. The two workings are connected by a line of float ore and in places where the surface is bare by outcroppings ; the management were confident that the vein extended at least that far. Since leaving the camp the vein (or a vein stated to resemble the Montana vein in general character) is reported to have been struck.

Uranus.—The Uranus vein is situated just above the forks of Pooly creek, a small stream tributary to Windy Arm. It is distant from the Montana vein about a mile in a southerly direction, and from the lake about a mile and a half. The elevation above the lake is approximately 2,000 feet. The Uranus vein is traceable by numerous surface outcrops in a direction a few degrees east of south from the north to the south branch of Pooly creek, a distance of about 1,500 feet. The vein crosses a high ridge separating the two creeks and is thus exposed naturally in depth for some hundreds of feet. A tunnel starting at the south fork has been driven 180 feet along the vein, which dips to the west at an angle of about 40° and varies in width from a few inches to three or four feet. It carries considerable quantities of highly argentiferous galena and also some native silver, ruby silver and iron and arsenic sulphides. A few tons of sorted ore have been shipped.

Other important veins in the vicinity of Pooly creek and its branches are the Joe Petty and the M. and M. The Joe Petty is a very strong vein. A shaft following the lead has been sunk at one point to a depth of about fifty feet, showing a vein fully six feet in width. The vein material consists of alternating bands of quartz and silicified and mineralized country rock carrying layers and scattered grains and crystals of the rich silver and silver-bearing minerals of the district. The M. and M. is a much narrower vein seldom exceeeding twelve to fifteen inches in thickness, but is very persistent in strike. It is traceable on the surface for several hundred feet at least. This vein is especially rich in places in high grade silver minerals such as pyrargyrite, stephanite and the sulph-antimonite referred as freibergite.

Another important group of claims is situated south of Pooly creek and about half a mile west of Windy Arm. This group includes, among others, Venus No. 1, Venus No. 2, and Ruby Silver. No work was being done on them at the time of my visit. Venus No. 2, is an exceedingly strong vein. The only work done on it consists of two shallow openings about 400 feet apart. These show a vein fully nine feet in width. The vein-filling consists of three and nine inches of quartz along the foot wall, followed by alternating bands of quartz and decomposed and mineralized country rock. The ore is principally argentiferous galena. Good assays in gold are stated to have been obtained from this vein. Venus No. 1 is a smaller vein. A shaft following the vein has been sunk on it to a depth of fifty-two feet. This shows a quartz vein, increasing in width from ten inches at the surface to about thirty inches at the foot of the shaft, bordered by several feet of decomposed and mineralized country rock, fissured parallel to the vein. Fifteen tons of ore obtained in sinking the shaft and shipped to outside smelters are stated to have averaged $65 per ton in silver. Ruby Silver is a narrow siliceous vein spotted, in places, with the mineral from which it takes its name. Very little development work has been done on it.

South of the Venus group, and apparently in the same zone of fracturing, are the Red Deer and Humper Claims. The Humper vein, as shown in a couple of small openings, has a width of about two feet. The quartz is bordered above and below by about a foot of decomposed iron-stained country rock which might be considered part of the lead. A shaft twelve feet in depth has been sunk on the Humper Extension, an adjoining claim on the east. The vein followed has a width of about fifteen inches.

The ore on the dumps showed galena, ruby-silver, stephanite and green copper carbonate, probably derived from tetrahedrite.

About a mile north of the Montana is the Big Thing group. The conditions here are different, as the country rock is granite. A considerable body of loose ore, principally argentiferous galena, evidently derived from a strong vein, occurs on one of the claims. The vein had not been determined at the time of my visit. A number of other veins are reported to cross the various claims, but were not examined.

The claims briefly described above comprise only a small proportion of those staked in the district, but on most of the remainder little or no development work has so far been done, and the time at my disposal did not permit me to make a systematic examination of them.

The general outlook for the camp is considered exceedingly promising, and its opening up marks an important event in the mining history of the country.

The mining conditions are not unfavourable. Most of the veins are situated at distances of from half a mile to four miles from the lake and at elevations of from twelve hundred feet to three thousand six hundred feet above it. Aerial tramways can therefore easily be constructed for the carriage of the ores to the lake shore for concentration and can also be used to take supplies to the mines. Miners' wages during the past season amounted to $3.50 per day for eight hours work, and ordinary labourers obtained the same amount for ten hours work. The cost of supplies, considering the short distance to the seaboard, and the almost continuous rail connexion, ought to be moderate. The climate, while severe during a portion of the year, will have little effect on mining operations.

A Reconnaissance Survey on the Stewart River.

Mr. Joseph Keele.

I left Ottawa on March 25, with instructions to make an examination of that portion of the Stewart river above Fraser falls, and as many of its tributaries as time permitted. I reached Whitehorse on April 6, where some delay was occasioned owing to the non-arrival of canoes, and from this point, travelling partly on the ice and partly on the Yukon river, arrived at Dawson on May 18. Provisions for the whole season, and a camping outfit, were procured at Dawson, and, accompanied by two men, I embarked on the steamer "*Prospector*" on May 22, her first trip for the season up the Stewart river. We reached Fraser falls, a distance of 260 miles from Dawson, five days later. Here I was joined by a third man and the party was complete.

When we arrived at Fraser falls we found the Stewart river in flood and hourly increasing in volume owing to the unusually warm and early spring. The river reached its maximum height on May 31 and did not subside sufficiently to allow us to proceed in our canoes until June 7. During this period the water rose to a height of 25 feet above

low-water mark at the head of the falls; it became extremely muddy, and a never-ceasing burden of floodwood and living trees torn from the banks was borne on its surface. This is the highest water which has occurred since 1898. The river afterwards rose on three occasions to a height of from 12 to 18 inches each time, the last rise being on July 3, and caused probably by the melting of snow on the higher peaks in the watershed ranges.

The only work previously done in this region was an exploratory topographic survey by Mr. J. J. McArthur as far as the mouth of Hess river, or South branch of the Stewart, in 1898. Consequently the greater portion of the season was devoted to making the necessary surveys for the preparation of a map.

A micrometer and compass survey was made from Mayo landing, a distance of 36 miles below Fraser falls, to a point 390 miles up the Stewart river; and for a distance of 45 miles up the Beaver river. Track surveys were made of the entire course of the Ladue river, and a portion of Rackla river. A good general idea of the relief of the region was obtained by a system of triangulation and sketches made with a small transit from several prominent mountain peaks. The surveys are now being plotted, and material will thus be furnished for an approximately correct map of a part of the country that, up to the present, has been almost entirely unknown.

The men who assisted me in the work are miners in the Duncan Creek district, who had an interest in the development of the country. They were highly efficient in every phase of the various duties assigned to them, and rendered excellent service.

The Stewart river above Fraser falls drains an area of about 120 miles in extent in an east and west direction, and about 80 miles north and south.

During its course through this area it receives four important tributaries, the principal one being Hess river or the South branch, which enters from the east at a distance of 55 miles from the foot of Fraser falls, following the windings of the river. Twenty-eight miles farther, Lansing river also enters from the east. Ladue river enters from the west at a distance of thirty-two miles above Lansing, and from the same direction Beaver river enters about seven miles above the mouth of the Ladue.

The headwaters of the Stewart river and its branches have their source either in the Ogilvie range to the north or in the Selwyn range to the east. These two mountain chains form the watershed between the Yukon and Mackenzie drainage basins in the region here described.

The entire drainage basin of the Stewart is of a mountainous character, and although much of the upland country of the area is composed of flat topped or gently rounded and wooded hills, there are high flanking ranges or single groups adjacent to the main ranges with peaks which measure from 6,000 to 7,500 feet above sea-level or almost as high as the most prominent peaks in the watershed ranges.

This mountainous region is traversed in several directions by a system of wide, interlocking valleys. The floors of these valleys are graded to as low a level as the character of the country will permit. Not all of them are now occupied by the river and its principal branches, although they all appear to be ancient drainage channels.

Evidences of a former glacial period are met with in various portions of the area. These consist of ice groovings and striae preserved on certain exposures of bed rock, the occurrence of drift at high altitudes, of boulder clay containing scratched and planed pebbles, and, above all, the characteristic topography which usually results from the smoothing action of a general ice sheet.

Until the observations made in the field have been laid down on the map, it will be impossible to give with precision any account of the geological features of the region. The rocks in general are closely analogous to those met with in the corresponding regions to the south and west.

The area between the Beaver river and the Stewart consists mostly of crystalline schists similar to those found in the Duncan Creek mining district, and described by the writer under the name of the Nasina Series in the Summary Report of the Geological Survey for 1904. These rocks appear to extend eastward up the Hess River valley, and are found in a few localities as far south as the MacMillan river. About ten miles below Lansing these schists are replaced by a series of rocks which are evidently much younger. These consist of dark carbonaceous and greenish argillites, and gray shales with occasional narrow bands of black limestone and sandstone hardened almost to quartzite. These rocks are exposed at intervals on the river banks as far as Beaver river.

Above the mouth of the Beaver river no rock appears on the river for a distance of forty-five miles, but beyond this point exposures are frequent. The rocks here consist of sandstones, grits, red and green slates and gray limestone. A section obtained on the bordering mountains to the south of the river shows a thickness of over 3,500 feet of these rocks. These rocks extend eastward for a considerable distance, and a similar series occurs on the MacMillan river.

North of the Stewart and Beaver rivers the mountains are composed principally of heavily bedded limestones and ferruginous slates. All these rocks are mostly of sedimentary origin with the exception of a portion of the crystalline schists, which are altered intrusives. Unaltered intrusive and volcanic rocks are also represented in this area, not, however, for any great extent, but occurring in small detached and irregularly distributed masses.

Several gold seekers entered this country during the Klondike excitement in 1898, but they do not appear to have done much prospecting. Those who passed down the Stewart river, while making the extraordinary journey from Edmonton, were intent on reaching Dawson as quickly as possible, and those who afterwards ascended the river devoted most of their time to hunting and trapping.

The portion of this region which, in the light of past experience, would seem to afford the most likely ground for the prospector in search of placer gold, is the area situated between the Beaver and Stewart rivers.

This area is mostly underlain by metamorphic schists, which are intruded in some places by igneous rocks, such as granite, diorite and diabase, and are similar in character to the bedrock in all the placer camps of the Yukon. Fine colours of gold were

obtained in the gravels in many of the small streams along the route, but whether there was sufficient to pay for mining could only be determined by the usual methods of opening up bedrock.

In the area between Hess river and the Lansing river, east of the Stewart, at least three creeks flowing into these streams are said to yield coarse gold. This portion was not examined by the writer. On Congdon creek, which comes in from the east about ten miles below Lansing, good surface prospects were obtained by one of the party.

Above the mouth of Mayo river the gravel bars on the Stewart are only slightly auriferous and have never yielded wages to the bar miner. Beyond the mouth of Beaver river the bars do not appear to be auriferous; the same may be said of the Beaver river, and although fine gold was said to have been found in 1898 on the bars of Rackla river, its principal tributary, no colours could be raised by the writer's party in that stream.

About one mile up, on a small creek nearly opposite the mouth of Rackla river, a small quantity of coarse gold was obtained in the surface gravels.

No gold-bearing quartz has, so far, been discovered in this region. Small bodies and stringers of vein quartz are of common enough occurrence in the area of metamorphic schists, but none which contained gold were seen on the portion of the area traversed.

A large body of quartz, in low, rugged ridges, crosses the Stewart valley about ten miles above Hess river, and a similar body occurs on Rackla river below the forks. Both are apparently barren of any mineralization.

There is a small band of native inhabitants living in cabins at the mouth of Lansing river, at which point Messrs. Frank Braine and Percival Nash have established a trading post. A number of Indians from Fort Good Hope on the Mackenzie river make a yearly journey to Lansing, hunting and trapping over the intervening country during the trip. A few white men also make a business of trapping; these confine their operations mostly to the country in the vicinity of Hess river. The principal land quadrupeds are the moose, caribou, mountain sheep, brown and black bear, wolverine, martin, wolf, lynx, fox, marmot, rabbit, beaver, mink and muskrat.

There is an abundance of fish in the rivers and lakes, such as salmon trout, white-fish, pike and grayling. The king salmon, coming up from the sea to spawn, were observed high up in the Beaver river, and several are caught at Lansing. These were the more vigorous ones, as the majority of the salmon are unable to ascend the Fraser falls.

The Stewart river opened and became free from ice at Lansing on May 10th. There was no frost between May 24th and August 23rd, and during this period the weather was very fine and warm. The snow disappeared almost entirely from the mountain ranges, and only a few of the highest peaks retained any on the first of August.

It was an exceedingly fruitful year in this locality. There was a great profusion of all the native wild fruit, such as blueberries, raspberries and red and black currants.

A garden planted by Mr. Braine near his house at Lansing produced very fine vegetables. All the varieties found in the gardens in the vicinity of Dawson can be grown here.

PEEL RIVER, IN THE YUKON AND MACKENZIE DISTRICTS.

Mr. Charles Camsell.

The field work assigned to me for the season of 1904 embraced a geologic and topographic reconnaissance of the Peel river, in the extreme northwestern portion of the Dominion. The inaccessibleness of the region, and the shortness of the season, necessitated an early start, and, in accordance with instructions received, I left Ottawa for Winnipeg about the middle of March. At Winnipeg supplies were purchased and shipped through the Hudson's Bay Company to meet me at Fort Macpherson in August, and later I proceeded to Dawson, where I arrived on the 14th of April.

At Dawson the interval between the closing of winter travel and the opening of navigation on the streams was consumed in the testing of instruments and in visiting and examining the placer mines of the Klondike creeks. During this period I was deeply indebted to Mr. J. B. Tyrrell for much kindness and hospitality. To Major Wood, also, Commandant of the Royal North-west Mounted Police in the Yukon, are my thanks due for assistance.

On May 22nd the party, consisting of six men with three canoes, left Dawson by ss. *Prospector* for Fraser falls on the Stewart river, which was not reached uutil the 26th. Another delay, occasioned by an early rise of water in the Stewart, prevented us from moving until June 5th. When a start was finally made, it was only with the greatest difficulty and some danger that any progress could be made. The velocity of the current occasioned large quantities of driftwood, and in many places the banks were completely submerged. Under these conditions we were eight days in getting as far as Lansing creek, a distance of eighty miles. Above Lansing creek the water gradually subsided and the travelling was much easier until we came within a few miles of where the actual survey was commenced.

At the mouth of Braine creek, a tributary of the Beaver river, the micrometer survey was begun, though a track survey was carried up from Williams' cabin at the cañon seven miles below, to connect with Mr. Keele's survey of the lower part of Beaver river.

It was my original intention on leaving Ottawa to follow identically the same route across the mountains as was taken by the prospectors in 1899, but I was dissuaded from this, on reaching Dawson, where I was informed that any other route would be preferable. Though I could not learn that anyone had ever taken a canoe across into Peel river waters by any other route than the Bonnet Plume pass, I did learn that Indians had come across from the Wind river to the Beaver river through a pass that was said to be very much lower than the Bonnet Plume. It was finally decided to find, if possible, this winter route, and follow it.

In ascending the Stewart river, we met Mr. Braine of Lansing creek, and from him obtained the necessary information as to how to find the pass to the Wind river. The Braine pass—the name I have adopted for this new route—though an easy winter route, is not a feasible one for canoes. Though we went through at a time when the water in Braine creek was probably at its best stage, we had to portage almost the entire route for fifteen and a half miles, of which distance the canoes were carried for three and a half miles.

A micrometer and compass survey was carried from the mouth of Braine creek through Braine pass, and down Nash creek to the Wind river, a distance of thirty miles.

From the mouth of Nash creek to the Peel river the course of the stream is almost true north; to save time, a careful track survey, checked by frequent observations for latitude, was all that was made. This distance is approximately one hundred miles.

We reached the Peel river on the 13th of July, and from this point a micrometer survey was recommenced and carried down the stream to a point ninety-eight miles below Fort Macpherson, where the western branch of the river first joins Mackenzie waters; from this point back again to Fort Macpherson by the central branch of the Peel river. The survey of this portion was completed on the 11th of August, and on the 15th the return journey to Dawson was begun. Altogether, 335 miles of micrometer survey, and 275 miles of track survey, were made on Peel river waters.

Returning, the route followed was that by the Rat river, through Macdougal pass, and into the Bell and Porcupine rivers, the same as that taken by Mr. W. Ogilvie in 1887. A small portion of new work was here done in surveying the central and largest outlet of the Rat river—the south branch, which was surveyed by Mr. Ogilvie, being impossible except in the spring. The Rat river empties by three branches into the Peel river, but the northern branch is an inconsiderable stream and only navigable in high water, so that no attempt was made to map it. In the ascent of Rat river we were particularly fortunate in having a great deal of rain and snow, which raised the level of the water sufficiently in the stream to allow of comparatively easy canoeing. The same conditions allowed us to get our canoes within 600 yards of navigable waters on the western side of the summit, a portage of that length being all that was necessary across the Mackenzie-Yukon divide at this point. Had we been a week or two earlier, or a few days later, we would probably have been compelled to make a portage of three or four miles in length.

The Porcupine river was followed down to its junction with the Yukon river at Fort Yukon, where we arrived on September the 8th, the actual travelling time from Fort Macpherson to Fort Yukon being twenty days. A track survey was carried all the way from Fort Macpherson to the boundary line of Alaska just below Rampart House, where it was closed.

After a delay of five days at Fort Yukon, we caught a fast steamer plying between St. Michaels and Dawson, and arrived in Dawson on the 17th of September.

Description of Routes.

Braine creek is a typical mountain stream, never in any part navigable for canoes. From its source—in two small mountain glaciers on the flanks of one of the highest peaks in the region—to its mouth is a distance of sixteen and a half miles. It has a general direction of S. 35 W., cutting almost directly across the strike of the rocks. The stream occupies a broad U-shaped valley, sometimes a mile in width, with the bordering mountains rising to a height of 3,000 feet on either side. The grade is always exceedingly steep and the volume of water is never very great.

Two cañons occur in the creek. The lower one—two miles from the Beaver river—is deep and narrow and about two-thirds of a mile in length. The second lies four and a half miles above the first, and is about three hundred yards long with a fall of about twenty-five feet.

Immediately above each of these cañons the bed of the stream expands and is almost entirely filled with sheets of ice, through which the water cuts narrow, winding channels. These ice sheets are probably formed during the winter. A great many of the small tributaries of Braine creek are fed from springs in the limestone, and these probably maintain a continuous outflow throughout the year, so that even in the coldest weather there must be a certain quantity of water flowing down the creek, thus accounting for the formation of the ice sheet.

Fourteen miles up, the stream divides, and to this point the canoes were dragged. Immediately below this point the valley is occupied by several small marshy ponds, among which the stream meanders with only a slight grade.

At the forks of the creek the valley divides, forming two passes, each of which brings one in a few miles into Peel river waters. Though the eastern pass is 200 feet lower than the western, the latter was selected as our portage route because it brought us into a much larger and more navigable stream than the other; but the eastern pass is the more direct route to the Wind river. Each of these passes is wide and open. A scrubby growth of willows and alders fills the bottoms of the valleys, while the sides are fringed with a scattered growth of spruce trees, which extend only a short distance up the slopes of the bordering mountains.

The elevation of the summit of the western pass is estimated at three thousand three hundred feet above sea level. From the forks of Braine creek to this summit there is a long gradual ascent of 350 feet, with a much steeper descent of 400 feet on the other side of the divide to the bed of Nash creek. The greatest elevation of the highest peaks in the neighbourhood of the pass is scarcely 7,000 feet.

Nash creek is considerably larger and longer than Braine creek. It has its source in a large lake, and its total length is about twenty-five miles. The upper half of its valley is very wide and is a continuation of the broad structural valley of the two arms of Braine pass. The lower half is narrower and more V-shaped, and inclined at a slight angle to the upper half. One mile above the portage Nash creek forks, the smaller branch also rising in a lake five miles beyond. The two branches, however, each occupy a part of the same wide valley, and are only separated from each other by a long narrow

ridge fifteen hundred feet above the bed of the stream. The grade of Nash creek is very steep, and though only one short cañon occurs, the rest of the stream is very swift and shallow and full of gravel bars. It is often bordered by cut banks of consolidated clay and gravel, which have a height of a hundred feet and more. From the north end of the portage trail to the junction with Wind river is a distance of twelve miles. The creek, however, enters the Wind valley nine miles below the portage, and flows in it for three miles before joining with the waters of the Wind river.

The vegetation on Nash creek is slightly different from that on Braine creek. Balsam, poplar and spruce grow in abundance on the flats of Nash creek, while none of the former tree was seen on Braine creek.

Topographically, the country between the Beaver river and the Wind river is one of rather rugged relief. Few prominent peaks occur, and from the top of any one of them a general accordance of level can be noticed. This general level gives an average vertical relief of about 3,000 feet, with a few peaks rising perhaps 500 feet above this.

The great wide valleys are longitudinal valleys, coinciding with the strike of the rocks, and these are joined by narrower and shorter transverse valleys. These great valleys have a general east and west trend, showing that their formation was due to pressure from the north and south.

During the glacial period the valleys alone were filled to a depth of 1,000 to 1,500 feet with glaciers, which, apparently, moved along the present grade of the streams. Evidence of glaciation can be traced to a height of about 4,500 feet above sea level, so that about 2,000 feet or more of the highest peaks protruded through the ice. The limit of glaciation corresponds fairly closely to the timber line, and is well shown by the rounded and graded appearance of the slopes and shoulders up to that point.

In the gradual retreat of the glacier up the valley of Braine creek, it evidently halted sufficiently long at each of the two cañons to allow of the formation of extensive terminal moraines. On the disappearance of the glaciers, the valleys of both Braine and Nash creeks were filled to a depth of, sometimes, 150 feet, with a heavy deposit of boulders, gravel and clay, the ground moraine of the valley glaciers, which was later subjected to deep dissection by the present streams. At present only a few small cirque glaciers exist, and these only on the northern sides of the mountains, where they are protected from exposure to the rays of the sun.

A section across the summit from the Beaver river to the Wind river shows a series of closely folded and sometimes faulted limestones and slates with some quartzite and conglomerate. Cutting these are diabase dikes and intrusive rocks. The succession in descending order is somewhat as follows : —Massive limestone becoming shaly at the base ; bands of black slate ; massive granular limestone containing fossils ; ferruginous slates weathering red ; dark conglomerate at the base. Remnants of a coarsely crystalized quartzite at the top of the series sometimes form the peaks of the higher mountains These strike as a rule from west to northwest, and dip at various angles, forming a succession of synclines and anticlines. The appearance of the ferruginous slates is a noticeable feature in the topography of the region in the neighbourhood of Wind river, for the slopes take on a dull reddish colour due to the oxidation of the iron in the slates.

Favosites, Productella and Atrypa Reticularis were obtained from the limestones at the summit and are probably Devonian forms.

With the exception of some limonite in the rocks at the pass, no indications of economic minerals occur. While a few small colours of gold were obtained on the Beaver river, these disappear entirely on Braine and Nash creeks.

The Wind river from Bonnet Plume pass to the Peel river has an estimated length of 132 miles. Nash creek enters it about thirty miles below this pass. It has a general direction of almost true north, and continues to flow for about forty miles below Nash creek through the mountains before entering the plateau region of the Peel river. In this section the stream occupies a broad U-shaped valley, timbered in some parts by spruce and poplar, but totally bare in others. In this the river flows in a broad shallow bed sometimes half a mile wide. When confined to one channel, the breadth of the stream, before its junction with Nash creek, is 100 feet. The sides of the valley decrease in height from 3,000 feet at Nash creek to about 2,000 feet at the northern edge of the mountains. In several expansions of the river bed large sheets of ice were still remaining at the beginning of July, similar to those occurring on Braine creek.

On leaving the mountains, the river emerges at once on to a rolling country of foot hills, later replaced by a perfectly level, wooded plateau, which extends northward practically to the delta of the Mackenzie river. The mountains present a rather abrupt face to the lower country, and appear to be unbroken by any great valleys except that of the Bonnet Plume river to the east. West of the Wind river they stretch away to the Little Wind river, beyond which they swing around to the north, and cross the Peel river near the mouth of Hart river, thus forming a great semi-circular basin inclosing the lower parts of the Wind and Bonnet Plume rivers, and in which a few outliers of the mountain range break the level of the region, rising to a height of about 2,000 feet.

The character of the stream in the foothills section is very uniform. With the exception of a short portion where it cuts through the Illtyd range of mountains and approaches the nature of a cañon, the bed is usually wide, shallow and filled with gravel bars. Few rock exposures occur, and the stream flows with a varying rate of from four to eight miles an hour.

The principal feeders flowing into the Wind river are the Bear river from the east, and the Little Wind and Hungry creek from the west. Of these the Little Wind river has a volume of water equal to about two-thirds of that of the main stream.

The topography of the mountain section of the Wind river resembles that given for the summit portion. The relief varies with the texture and hardness of the rock. The most noticeable feature is the abruptness with which the range rises from the floor of the plateau in the portion east of the Wind river. West of this—where the range swings around in a curve to the north—it is bordered and flanked by lower ranges of foot hills, which make a gradual slope eastward down to the level of the plateau.

The foot-hill ranges are usually low, rounded hills, seldom more than 2,000 feet in height, and more often less than 1,000. Their origin is due to the same orographic movement in the earth's crust which resulted in the upheaval of the Ogilvie range. The

majority of them are anticlinal in structure; but several smaller hills are due to faulting on a large scale. They extend northward beyond the Peel river and eastward to the Snake river. Almost in the centre of this area is a large low lying basin, covering over five hundred square miles, and occupied by scarcely disturbed Tertiary rocks. This basin is almost completely inclosed by the encircling foot-hills, and lies between the Wind and Bonnet Plume rivers, extending southward some fifty miles from the Peel river.

As in the summit section, the Wind river valley—as well as other valleys in the neighbourhood—was occupied by valley glaciers, filling them to a depth of fifteen hundred feet or more. These glaciers, on leaving the mountains and entering the rolling country, spread over the whole plateau, covering the surface with a variable thickness of boulder clay and smoothing and rounding off the tops of the foot hills that did not attain a sufficient elevation to protrude through the ice sheet.

Existing glaciers were seen only on the flanks of the high mountains opposite the mouth of Nash creek; but that others have existed in other portions of the Wind River valley is proved by the presence of some basin-shaped cirques, particularly on the west side of the valley.

The rocks of the mountain section of the Wind river consist of ferruginous slates, limestones and sandstone which alter to crystalline limestones and quartzites, with some conglomerate. These strike nearly at right angles to the course of the stream, and dip at all angles, being tilted into a series of anticlines and synclines. Near Bear river the sandstone forms some of the higher peaks in the region, and shows the characteristic weathering of this kind of rock in being eroded into all sorts of fantastic shapes. Sharp pinnacles and columns of rocks and steep precipices are noticeable features wherever this sandstone occurs. Alluvial fans, too, are common.

A great quantity of iron ore float occurs in the drift of Bear river. The same float also occurs in large quantities on the Bonnet Plume and Snake rivers. Only very fine colours of gold were found in the gravels of the Wind river.

On leaving the main range of mountains the geology changes immediately. Though the rocks of the Illtyd range of mountains and of Mount Deception are dolomitic limestones, probably of the same age as the rocks of the main range, these are completely surrounded by almost undisturbed Cretaceous rocks, well exposed on the streams about ten miles above the mouth of the Little Wind river. They consist of sandstone of soft texture, and conglomerate containing ironstone nodules and some fossil wood. This Cretaceous area extends northward along the Wind river to a point a few miles below Mount Deception. It is then replaced by more recent rocks of Tertiary age, through which the river flows down to a point one mile from the Peel river. The contact below Mount Deception is covered with drift, but is well shown near the Peel river, where the soft sandstone and lignites of the Tertiary basin are seen to rest unconformably on the upturned and truncated edges of some black slates. This section shows forty feet of boulder clay resting unconformably on fifty feet of soft sandstone, with which is interstratified eight thin seams of lignite. These rest with an unconformity on the rusty black slates. Higher up the stream one seam of lignite, six or seven feet thick, is exposed on the west bank of the stream; but the lignite is still in a primary stage of

development and shows the twigs, leaves and moss of which it is composed, and even some blebs of resin. The lignite, when dry, burns fairly readily, giving off an odour of burning resin, and leaving much ash.

Colours of gold were obtained on the Little Wind river and on Hungry creek. Prospectors are said to have found coarse gold on the latter stream, but time did not permit us to verify this report.

The Peel River.

The Wind river enters the Peel river one mile above the lower end of the upper cañon, or 201 miles above Fort Macpherson. Above this, the stream was not explored, but the cañon is said to extend up to the Aberdeen falls, an estimated distance of about thirty miles. The cañon is cut to a depth of 150 feet in hard black slates, and its average width is about 500 feet. The river, here, has a velocity of from four to seven miles an hour, and is apparently easily navigable for canoes. Water marks stand at a height of twenty-five feet above the normal level, and when the stream is at this stage the cañon would be impassable.

After leaving the cañon the stream flows eastward for fifteen miles through the low level Tertiary basin, when it enters the lower cañon, just above which the Bonnet Plume river enters from the south, discharging a volume of water slightly greater than that of Wind river. Nearly opposite the mouth of the Bonnet Plume, Mountain creek enters from the north and it is this stream that the Indians ascend in making their winter portage across the great bend in the Peel river.

The lower cañon is formed by the stream cutting a deep and narrow defile through the low range of hills bordering the Tertiary basin on the east side. The walls of this cañon are almost vertical and rise to a height of about 500 feet, giving an erroneous impression of dangerous navigation.

The course of the stream below the lower cañon is still easterly for thirty-eight miles, or as far as Snake river, from which point it turns off almost at right angles to its former course and flows northerly. In this section the stream has a velocity of from four to eight miles an hour. Swinging from one side of the valley to the other, it cuts deeply into the soft shales and sandstones of which the plateau is built, forming steep cut banks, which are constantly dropping blocks and fragments into the rushing stream below. The banks of the valley at the cañon are 500 feet in height, and from this point down to within thirty miles of Fort Macpherson the stream flows through the high Peel plateau, cutting a deeper and deeper valley northward till the banks attain a maximum height of 1,000 feet. The plateau is level or gently undulating, carrying on its surface several muskeg lakes. It is usually forested, and covered with moss, a few inches below which the ground is frozen during the whole year.

The Snake river, sometimes called the Good Hope river, enters the Peel river in the corner of the large elbow that the latter makes. It was originally supposed to be the main stream, but an estimate of its discharge, taken about the middle of July, shows the Peel river to be about four times as large. It was explored for a distance of about twenty-five miles, but from the summit of one of the neighbouring hills, its course

through the plateau could be traced for about fifty miles, flowing in a northwesterly direction from near the eastern border of the Ogilvie range. It has a velocity of four or five miles an hour, and occupies a valley about 700 feet deep and half a mile wide.

From the Snake river to Fort Macpherson is a distance of 147 miles, and in this section there is little variation in the general character of the stream. The valley has an average width of one mile, the greater part of which is taken up with gravel-bars and wooded flats, and it is bounded by banks of clay, sandstone and shale which vary in height from 600 to 1,000 feet. The average velocity of the current gradually decreases northward, and though it frequently attains a speed of eight miles an hour, as we approach Fort Macpherson it drops to two miles an hour.

Few streams of any consequence enter the Peel river below Snake river. As the course of the stream is parallel to that of the Arctic Red river, which lies to the east at a distance of only thirty or forty miles, no large streams could be expected to enter from this side. Of the smaller tributaries the most important are George river and Satahs river, and two others, which are nameless, of almost equal volume. These drain the level lake country on the top of the plateau. George river, thirty-two miles below the Snake river, is a very small stream about forty feet wide; while Satahs river sixty-two miles below this, has a width of 120 feet. The other two streams entering from the east each have a width of about 100 feet with a very sluggish current.

The Peel river has a much larger area to drain on the west side, and naturally receives more water than from the east. The principal streams entering from the west are Cariboo creek, Trail creek, Road river and Stony creek, all of which have very steep grades and draw their water from the range of mountains that runs parallel to, and about 25 miles west of the Peel river. They all occupy rather wide valleys that are cut deeply into the high plateau, and none of them are navigable for canoes. Road river, twenty-four miles above Fort Macpherson, is the largest tributary below Snake river, and has a width of about 100 yards. Trail creek is the stream which the natives ascend in making their winter portage across country to the mouth of the Bonnet Plume river.

At Satahs river the Peel river emerges from the high plateau, and enters what is probably the coastal plain. The transition from the one to the other is very abrupt, and the escarpment of the plateau is about 700 feet high. The face of this escarpment has a semi-circular shape, the western arm of which has a maximum elevation of 1,000 feet, while on the east side this level decreases gradually to about 400 feet. The stream skirts along the eastern face of the western arm of this plateau escarpment, sometimes cutting through projecting points or outliers of it, until, as we approach Fort Macpherson, it leaves it altogether. Fort Macpherson itself stands on one of the outliers or remnants of the plateau, and there are numerous others to the east.

Fort Macpherson consists of the Hudson's Bay Company's establishment, a Church of England mission and a small detachment of the North-west Mounted Police.

Below Fort Macpherson the Peel river enters the flood plain of the Mackenzie delta, in which all, or nearly all, the land is submerged in the spring floods. The southern edge of this delta is a line drawn from the Fort to Point Separation, and

marked by several low ridges, similar to the one on which the Fort stands. From Point Separation the trend of the higher land is northward, skirting along the east side of the eastern channel of the Mackenzie, and culminating in a low range called the Reindeer hills, below Campbell river. West of the Peel river the margin of the delta is the eastern face of the high escarpment mentioned before, which trends slightly west of north from Fort Macpherson, crossing the Rat river below the mouth of Long Stick creek and gradually approaching the mountains west of it until it merges with them and disappears at the base of Mount Goodenough. The boundary of the delta north of this is then the base of the mountain range.

Twelve miles below Fort Macpherson the Peel river divides, the eastern channel joining the Mackenzie river by two mouths twelve miles below. The western channel, which locally goes by the name of the Huskie river, follows along the western edge of the delta and does not join the Mackenzie waters until ninety miles below. Between these two channels are several smaller channels of the Peel river, and these, with the Mackenzie river channels, form a network of streams which would take years to thoroughly survey.

The delta of the Mackenzie and Peel rivers covers a very large area, 100 miles from north to south, with a width of about 70 miles in its broadest part. Besides the streams which ramify through it, the most striking feature is the number of lakes that cover its surface everywhere. One can only get an idea of the quantity by looking over the delta from one of the mountains to the west of it. It is heavily wooded with spruce as far as latitude 68° 30', where this tree gradually dies out and only willows and alders remain. These extend northward nearly to the sea, where the more recently formed land is entirely devoid of any vegetation.

The few facts observed with regard to the glaciation of the plateau section of the Peel river point to a northward movement of the ice. According to McConnell's theory the ice from the Archaean gathering ground to the east of the Mackenzie river poured westward through the gaps in the mountains to the east of the river, until it reached the main axial range, and was then deflected to the northeast down the valley of the Mackenzie to the sea. From the mountains to the west only large valley glaciers from 1,500 to 1,800 feet in depth issued from the valleys, and spread over the surface of the plateau, moving slowly northward and perhaps slightly eastward, till they met and merged with the northwestward moving sheet of ice from the Archaean highlands to the east.

On account of the softness of the rocks and the universal covering of moss, glacial striæ are never seen on the plateau itself. On the south side of Mount Goodenough at an elevation of 1,500 feet, grooves and scourings which may be due to glacial action were noticed on a saddle backed ridge. These have a bearing of N. 20° W., but whether caused by a small mountain glacier or by the large ice sheet, it is difficult to say. No existing glaciers were seen in that region. Unmistakeable evidence, however, was obtained that a mountain glacier had existed on the western face of Mount Goodenough.

The rocks of both the upper and lower cañons of the Peel river consist of a series of closely folded black slates, with some bituminous limestone. The strata have been much crushed and crumpled and many faults appear, while the rock itself has been

greatly sheared and brecciated. The texture of the slates is very fine-grained, but it contains some crystals of pyrite disseminated through it, and some bituminous matter. These slates contain no fossils, but from their lithological resemblance to some bituminous shales and limestones on the Mackenzie river, they have been tentatively referred to the Devonian period.

The rocks of the Tertiary basin lying between the two cañons consist of soft sandstone, with some thin seams of lignite, overlaid by more sandstones with pebbles, with clay and some very thick beds of lignite. One bed of lignite near the top of the series is thirty feet in thickness and fairly persistent, appearing in two exposures four miles apart with a shallow syncline between. Associated with this, and somewhat below it, is another seam eight feet in thickness. The lignite has been ignited by some cause and portions of it are now burning. Great landslides and patches of reddened shales in other sections of the valley indicate places from which the lignite has been consumed. These beds, like similar beds on the Mackenzie river at the mouth of Bear river are now burning, and have been burning for a great many years.

The geology of the Peel river below the cañon is simple, and sections of it are always exposed on the valley banks. The strata have been folded into a series of long and gentle undulations, which strike almost north and south, parallel to the bordering mountain range. A section five miles below the cañon shows about 200 feet of yellow and red shales, resting on massive sandstone 100 feet thick. Underneath is about 150 feet of rusty pyritous shales, very fissile. Overlying all is the glacial drift with a depth of about forty feet.

On the Snake river the rocks consist entirely of soft gray argillaceous sandstones, and in the low range of mountains on the west side of the river these same sandstones become slightly indurated, approaching the nature of a quartzite.

Below Snake river the Peel river follows the strike of the gentle undulations of the plateau, so that there is little variation in the character of the rocks. Argillaceous sandstones with beds of clay merge gradually into sections in which the clay occupies a much larger proportion or changes to shale. In places the sandstone is concretionary or contains the peculiar pressure figures known as "cone-in-cone."

A few miles above George river is the "Alum hill" of the early explorers, where some epsomite has been leached out and deposited as a crust on the clay of the river bank.

On leaving the plateau at Satahs river only sandstones and conglomerate are exposed in the cliffs of the river banks. These sandstones are very fossiliferous, some of the beds being made up almost entirely of fossils of a variety of *Tellinidae*.

Fossils were obtained in several parts of the Peel river from Snake river down to Fort Macpherson, and all are referable to the Cretaceous period.

Below Fort Macpherson only alluvial sands and clays are exposed on the river banks, and these are being built up and added to year by year when the streams are in flood and inundate the whole delta.

The mountain range to the west of the delta, which attains an elevation of more than 3,000 feet, is built up of slightly folded strata, and is characterized by flat or gently rounded summits. At the base is a thick series of black shales, which towards the top contain beds of hard gray ironstone. These latter weather red and are conspicuous along the face of the mountain. The shales are replaced upwards by argillaceous sandstones and these again by siliceous sandstones. The latter become metamorphosed to quartzites and constitute the upper members of the series. These strata are persistent westward up the Rat river and to the other side of the divide, and, from their fossils, are also referable to the Cretaceous period.

Placer gold does not occur on the Peel river below the Wind river, and the only products of economic interests in the rocks are the beds of lignite, some bituminous coal, epsomite and perhaps petroleum.

Rough estimates were made of the discharges of some of the streams and the following results were obtained :—

Wind river on July 14th	5,402 cubic feet per second.
Snake river on July 20th.................	6,960 " "
Peel river at Fort Macpherson on July 31st..	49,206 " "
Peel river above Wind river on July 14th...	15,136 " "

The Bonnet Plume River is as large if not larger than the Snake river.

The Unuk River Mining Region of British Columbia.

Fred Eugene Wright.

INTRODUCTION.

The occurrence of valuable ore deposits and placer gold near the headwaters of Unuk river, British Columbia, has been known in a vague way for many years and during the past two seasons definite steps have been taken to develop its resources systematically. Interest has been shown by prospectors and miners, not alone in this locality, but also in the entire mineral belt situated along the eastern flank of the Coast Range granite and not far distant from the International Boundary line. Discoveries of ore bodies, which appear to warrant careful investigation, have been made at several points in this zone recently, notably near the head of Portland canal, also up Unuk and Stikine rivers, and farther north near Caribou Crossing. From a geologic and economic standpoint, these regions are practically unknown and, with the exception of brief notes by Dawson (*a*) and Brooks (*b*), have not been described in detail.

(*a*) Dawson, G. M., The Yukon District, N.W.T. Geol. Nat. Hist. Survey, Canada, new series, Vol. III., Pt. I., 1887–1888 B.

Report on an Exploration from Port Simpson on the Pacific coast to Edmonton on the Saskatchewan, embracing a portion of the northern part of British Columbia and the Peace River country. Geol. Nat. Hist. Survey, Canada, 1879–1880 B.

(*b*) Brooks, A. H., Preliminary Report on the Ketchikan Mining District. Prof. Paper No. 1, U.S. Geol.Survey, 1901.

In September, 1905, the writer made a hasty reconnaissance trip to one of the localities by way of Behm canal for the purpose of examining its prospects and collecting data of geologic interest. He is much indebted to Mr. J. W. Daily, manager of the Unuk River Company, for many courtesies extended which aided greatly in furthering the investigation. During the past year the International Boundary line has been permanently established by the Commission and the uncertainty which has heretofore existed as to its exact position, thus removed.

GEOGRAPHY.

Unuk (or "Junuch"="Dream," in the language of the Tlingit Indians) river is one of the four large transmontane streams which rise in British Columbia either beyond, or well within the Coast Range, and crossing the International Boundary line, enter tide water on the Alaskan coast. Unuk river is about 54 miles in length, and with its tributaries drains the Pacific side of the Coast Range divide between Stikine river on the north, and Portland canal on the south. At its mouth the river has formed a wide delta deposit which is gradually filling Burroughs bay, a deep water indentation adjoining Behm canal, about 60 miles northeast of Ketchikan, Revillagigedo island, South-eastern Alaska. The river is swift and too shallow to permit river transportation on a large scale, and is furthermore obstructed by three cañons which can be passed only during periods of low water and then by canoes or small boats alone.

At its source a narrow divide leads over to a branch of Iskoot river along which prospectors can pass and enter the rolling plateau lands of British Columbia. This natural entrance from the coast into British Columbia has long been known and would have been used many years ago had the natural obstacles at the start on Unuk river been less formidable. Within the past three years, however, these conditions have been improved by the construction of a wagon road from the mouth of Unuk river to a prospect 42 miles inland. The road is at present twenty-five miles in length and when completed will furnish easy access into the mineral belt and thus increase its value materially.

The fiord-like valley of Unuk river is bounded by steep glaciated mountains 4,000 to 10,000 feet high, frequently rising sheer from its valley floor. It has been shown by Messrs. Spencer and Brooks (a) of the U.S. Geological Survey that the large rivers which traverse the Coast Range are probably antecedent in character and have preserved their original drainage courses during the mountain uplift.

In glacial times the ice streams followed these same lines, scouring them thoroughly and even making deep incisions into the country rock itself, so that at present the land forms are those of an intensely glaciated region. The usual features of glaciation—U-shaped valleys, hanging valleys, glacial terraces, rounded mountain tops, glacial erratics, flutings and grooves—abound and show by their freshness that only a small amount of erosion has been accomplished since the glacial epoch. On several of the mountain slopes the work of ice erosion is still being continued by small ice streams, the

(a) Spencer, A. C., Pacific Mountain System in British Columbia and Alaska: Bull. Geol. Soc. Amer., Vol. 14, pp. 117–132.
Brooks, A.H., Ketchikan Mining District, Prof. Paper, No. 1. U.S. Geol. Survey.

last remnants of the huge ice sheets which formerly covered this entire area to a depth of over 6,000 feet.

Along the banks of Unuk river timber of good quality occurs in occasional patches and consists chiefly of spruce, hemlock, cedar, cottonwood, with some balsam fir trees near its head. Trees of spruce and hemlock, four to six feet in diameter, are not uncommon and are reported by lumbermen to be of fair quality. The quantity and supply of timber are sufficient to supply mining purposes for many years. The underbrush is dense and, together with the wet climate and the malevolent Devil's club *(Echinopanax horridum)*, add to the difficulties to be overcome by the prospector.

GEOLOGY.

The geologic section exposed by the deep Unuk River cut, affords an unusual opportunity for the study of the Coast Range from many different view points. In a broad way its consideration may be resolved into a study of the intrusive Coast Range granite and the adjoining belts of altered sedimentary rocks on the east and west.

The Coast Range granite belt, which is traversed by Unuk river, is a small part of an immense granite batholite (*a*) nearly 1,000 miles in length and 30 to 60 miles in width which extends from Fraser river to British Columbia in a northwesterly direction, parallel to the coast, to the White river basin in the Yukon district. The Coast Range granite is one of the master features of the geology of this entire coastal strip and deserves careful study, not only by the geologist, but also by the prospector, since the major portion of the ore bodies which have been discovered probably have a genetic relation to the intrusive granite (*b*). From evidence obtained at other points it has been shown that the intrusion of the Coast Range granite took place between Upper Jurassic and Middle Cretaceous times.

Petrographically the field term, granite, applies to only a small part of the intrusive rock types. The prevalent type is less siliceous and ranges from grano-diorite to diorite and gabbro in composition with hornblende and biotite as coloured constituents and titanite as a frequent accessory component. As a general rule hornblende appears to be more abundant near the coast, while biotite predominates near the inland border of the batholite. Near the coast the granite is also more noticeably gneissoid in aspect and contains abundant inclusions of the intruded schists near its contact. These inclusions become more and more coarsely crystalline as the contact recedes until finally they resemble basic or acid differentiation products and are gradually lost sight of. It is a characteristic feature that while aplitic and particularly pegmatitic dikes are extremely abundant near the western contact of the granite and form an intricate network in the adjoining schist areas, they are rare and practically absent in the central parts of the massif. On its eastern flanks acid dikes occur frequently but are far less abundant than on the coastal side. The absence of minette and similar basic differentiation dike products is noteworthy and may be due to the fact that the acid dikes are pegmatic rather

(*a*) See Geologic Map of the Dominion of Canada, Western sheet, No. 783. Edition of 1901.

(*b*) Spencer, A. C., the magnetic origin of vein forming waters in Southeastern Alaska. Trans. A. I. M. E., Vol. XXXVI., pp. 971-978.

Brooks, A. H., Ketchikan Mining District. Prof. Paper No. I., U. S. Geol. Survey, 1901.

than aplitic in character and therefore are not, strictly speaking, differentation products.

The importance of the pegmatites becomes apparent when their mode of formation from solutions emanating from the intrusive mass is considered. They represent only a small part of the work accomplished by the pneumatolytic solutions of the granite and are a silent but convincing witness of the great volume of pneumatolytic solutions which accompanied the batholitic intrusion. The intimate connexion of ore bodies in southeastern Alaska with the intrusive masses has been proved directly in several instances and is inferred in a number of the remaining deposits.

Considered as a whole, the Coast Range granite has not produced the ordinary type of contact metamorphism in the rocks which it intrudes. On approaching its western contact from the coastal side, as exposed along the shores of Behm canal, a change in the invaded sedimentary rocks is noted from slates and argillites to phyllites and mica-schists and, still nearer, often to gneiss. The many types of contact hornfels are rare and spotted schists do not form an integral part of the complex. The strata are intensely folded and were undoubtedly deeply buried at the time of the granite invasion. In that position, deep seated metamorphic forces were active and had undoubtedly heated and altered the rocks to such an extent that the granite intrusion did not disturb their equilibrium greatly; its chief effect was rather to accentuate the process of crystallization already in force and to increase their power than to replace them by others. This coastal strip, whose contact with the granite can at present be traced only with difficulty, offers, therefore, an excellent example of the metamorphic changes produced by granite at a deep seated level.

It is significant that in the Ketchikan district no ore bodies of consequence have been found in this zone of deep seated metamorphism, while rocks farther away from the granite and at the same time nearer the surface during its invasion, frequently show traces of contact metamorphism (spotted schists and the like) and contain valuable metalliferous deposits. The folded character and lack of uniform structure of the strata near the granite contact may also account, in part, for the absence of commercial ore deposits, since they offer no decided lines along which concentration could take place as in the isoclinal schists of the Juneau district.

East of the inland border of the granite the character of the invaded rocks is noticeably different. The slates and sandstones are less altered and typical schists and gneisses are rare. Folding, and particularly faulting, are common and characteristic of the entire complex. The granite contact line is sharp and frequently traverses the bedding planes of the invaded strata. Although its general trend is parallel to the Coast Range the actual line in the Unuk river exposures undulates locally and crosscuts the strata at variable angles. The intruded rocks are often indurated and heavily mineralized with sulphides near the contact and show their evidence of metamorphism by the intrusive mass.

On comparing the metamorphic effects of the intrusive granite along its western and eastern flanks decided differences are thus apparent. On the coastal side, near the contact, the metamorphism is of the deep seated type, gneisses and schists predominate

and are cut by innumerable pegmatite dikes ramifying from the granite. Mineralization by sulphides is not pronounced. Farther to the west, and at some distance from the contact, evidences of contact metamorphism increase, as also the degree of mineralization; valuable ore bodies have been discovered within this latter zone. Along the eastern border of the granite, on the other hand, the metamorphism is of the contact type, argillites and slates predominate and are often indurated and heavily impregnated with sulphides. Well defined ore bodies have been found in the near vicinity of the granite contact. The geologic interpretation of these data indicates clearly that the rocks to the east of the granite were less deeply buried at the time of its invasion than those on the coastal side. In other words, the inland rocks were then above the zone of deep seated metamorphism (rock flowage) and were, therefore, profoundly affected by the invading intrusives and accompanying pneumatolytic solutions. Furthermore, the mineral-bearing solutions emanating from the granite encountered new conditions of temperature and pressure on invading the adjacent sedimentary rocks and deposited then, as supersaturated solutions in their new environment, a portion of their dissolved contents, especially the metallic sulphides.

Although in such a large belt the phenomena of contact metamorphism are not so pronounced and concentrated as in the contact aureole of a small intrusive boss, they are more extensive and, on a large scale, equally as varied. It has been frequently observed that in a small contact aureole different contact minerals are found at different distances from the intrusive mass and that under similar conditions an evident relation exists between a given contact mineral and its distance from the invading rocks; and in a general way this law has been found to hold true for this eastern contact zone of mineralized sedimentary rocks.

The age of sedimentary complex east of the granite has not yet been determined accurately because of insufficient fossil evidence. It is probable, however, from the work of Dawson on Stikine and Skeena rivers that they were deposited chiefly during the Palæozoic Era.

Occasional belts of included sedimentary rocks were observed within the granite belt and found to be in a highly metamorphosed condition. They vary from argillites to mica, hornblende and calc schists of various types, and occur in long bands, often intensely folded, and trending usually parallel to the course of the range. As a general rule they appear more frequently near the mountain tops than in the valley. During the past summer two prospectors located a claim, the Cheechacho, about a mile below the International Boundary line on a vein two feet wide in such an included schist band, striking east and west and dipping 50° north. The vein carries pyrite, chalcopyrite, and pyrrhotite and is reported to give low assay values in gold. The schist band is cut by numerous offshoots from the intrusive batholite and deserves mention, since it contains the only vein on which work has been accomplished within the Alaskan portion of the Unuk river section.

Of interest are comparatively recent lava flows which were extruded near the granite contact, and, following Cañon creek and Blue river valleys to Unuk river, spread over its valley floor and forced its waters over to the south wall, where they now pass by way of the three narrow cañons indicated on the map. The volcanic ash from

these eruptions can still be seen as black patches on the glaciers of the mountain peaks 8 to 10 miles distant. A few miles from the mouth of Blue river, the lava has dammed the valley to such an extent that a long lake has been formed and serves as a natural settling tank into which the turbid glacial stream flows, and from which it issues practically free from sediment.

The foregoing considerations tend to show that the belt of sedimentary rocks east of the Coast Range granite is a favourable one for prospecting, and deserves thorough investigation. As the inland border of granite lies entirely on the Canadian side of the International Boundary line, the Coast Range mineral belt is in British Columbia, and locations must be made in accordance with its laws.

MINERAL DEPOSITS.

The occurrence of placer gold near the headwaters of Unuk river and its tributaries has been known for many years. In the earlier eighties prospectors discovered gold-bearing gravels up Sulphide creek (See map) and spent several seasons profitably in extracting the gold by means of rockers and other primitive methods. The difficulties of transportation, however, were so great that they ultimately abandoned their claims. In the succeeding years occasional prospectors visited the region, relocated the placer deposits, and also discovered well mineralized veins carrying good values in silver, gold, and lead. A primitive trail was built along the north bank of the river, and access to the region thus facilitated. The present wagon road follows approximately the blazes of this old trail.

The most promising claims which have been staked are situated on Sulphide creek, and have been acquired by the company interested in construction of the wagon road. Other locations have been made near the head of South Fork, also near Boulder creek and Cañon creek (See sketch map).

SULPHIDE CREEK.

Recent discoveries have been made on this creek near its mouth, and consist of two veins which have been developed by several short drifts and open cuts. One of the veins outcrops along a narrow gulch and has been traced about one thousand feet up the gulch. It strikes usually N. 25° W., dips 30°-60° N.E. and varies in width from 2 to 8 inches. The vein minerals are chiefly tetrahedrite (gray copper), pyrite, sphalerite, galena and native silver ; near the surface they are usually altered and enveloped in a soft ferruginous matrix of weathering products. The native silver is a product of the surficial alteration of gray copper. About 100 tons of ore are reported to have been taken from this vein and to have given high assay returns, particularly in silver. The country rock consists of altered limestone and breccia with some quartzite and slate, cut by intrusives of several types. The second vein outcrops a short distance south of the first vein, and is exposed along the face of a steep cliff where it is easily recognized by its brown oxidized coating. At the surface it appears to be 20 to 30 feet wide and is heavily mineralized in spots with pyrite, fine galena (steel galena) and occasional sphalerite and chalcopyrite. Native gold is said to have been observed in the oxidized portions of this vein which has been prospected by a short tunnel 25 feet long at 1,400

feet elevation above sea-level. The vein shows distinct banding and strikes N. 5° W. with dip 80° to 85° E. A fine-grained basic dike is exposed along the west side of the tunnel. On both these veins the development work which has been accomplished is not sufficient to permit definite statements in regard to their future. The indications, however, appear sufficiently favourable to warrant the test which the company plans to give the property in the near future.

At the junction of Sulphide creek and Unuk river the river gravels contain some free gold, and fine colours can be seen in every pan of material tested. The gold is flaky and considerably worn. No thorough sampling has yet been done and depth to bed-rock is unknown. As the river valley, however, is wide and has passed through a long period of glacial erosion, it is probable that bed-rock is at some distance from the surface. Local irregularities were observed in the bed-rock floor near the placer gravels and similar variations may also be expected at the claims. It appears that these placers might be exploited by dredging, but large boulders are likely to be encountered.

South Fork.—Near the head waters of South Fork, below Sulphide creek, a second group of claims has been located 16 miles above its junction with the Unuk river, on veins within the sedimentary belt east of the Coast Range granite. These claims were not visited by the writer. Well defined deposits are reported and plans for future development are contemplated.

Boulder Creek.—Below South Fork on the same side of Unuk river prospects have been located on similar veins near Boulder creek, a glacial stream, about ten miles in length and rising near the Coast Range contact.

North Fork.—The territory drained by North Fork and by Glacier creek, two glacier-fed streams reported to be about 15 to 18 miles long respectively, has not been prospected systematically. The ore bodies which have been discovered are similar to others in this belt, and are frequently rich in galena, with good values in silver. The same statement applies to the region near the headwaters of Unuk river.

Cañon Creek.—In the vicinity of Cañon creek several ore bodies have been discovered, and are significant because of their close proximity to the granite contact along which Cañon creek has cut its course. The principal prospects near Cañon creek are the Black Bear claim and the Daily Boy group. The first is located on a vein 2 feet wide, outcropping along the selvage of a diorite porphyrite dike, and contains auriferous pyrite and pyrrhotite. The Daily Boy group is located in a gulch adjacent to Cañon creek, on veins occurring in altered black slates, argillites and quartzites. The entire assemblage of strata is folded and faulted considerably, and is characterized by intense induration and mineralization by sulphides, especially pyrite. On weathering they often become covered with a deep brown crust of ferruginous compounds, not unlike brown paint in appearance. The complex is cut by lamprophyric dikes of variable width and loose contact selvages. The veins which have been discovered in this gulch contain, besides pyrite, pyrrhotite and occasionally galena and sphalerite. No development work of note has been done on either of these prospects.

SUMMARY.

The geologic cross-section exposed by the Unuk river valley, across part of the Coast Range, consists of two parts: on the west, a wide belt of Mesozoic granitic masses, formed during the same general period and grouped into one great unit, the Coast Range batholite, which on the east intrudes partially metamorphosed, and probably Palæozoic sedimentary rocks in which ore deposits have been discovered. A discussion of the type of metamorphism of this rock-complex leads to the inference that its metamorphic changes were largely due to the contact action of the intrusive granite: that the impregnation of these rocks by metallic sulphides was essentially concomitant with their contact metamorphism; that at the time of the granitic invasion this sedimentary belt was nearer the surface than the invaded strata on the coastal side of the batholite; and that the different physical conditions resulting from differences in relative position to an intrusive are important factors in determining, not only the type and intensity of metamorphism, but also the kind and degree of sulphide mineralization.

From these considerations it is inferred that the sedimentary belt to the east of the Coast Range granite in the Unuk river section merits investigation and may reward careful prospecting for ore bodies. The difficulties of transportation which have been encountered heretofore will be materially decreased by the completion of the wagon road to Sulphide creek. Prospectors will then be able to devote a large part of their energy to the search for and development of metalliferous veins in the region.

Graham Island (of the Queen Charlotte Group, B.C.)

Dr. R. W. Ells.

The greater part of the season of 1905 was devoted to an examination of the coal deposits and other possible mineral resources of Graham island, the largest and most northerly of the Queen Charlotte group of British Columbia. The party left Ottawa on May 10th, and after a week spent in a further examination of the Quilchena and other coal areas in the Nicola Valley, which had been examined in detail the previous year, reached Vancouver on May 21st. Here, after hiring men and securing outfit and supplies, we sailed by the *Princess Beatrice* on the 26th, and reached Skidegate, via Port Simpson, on the evening of May 31st.

It was here found necessary to pack our supplies and outfit inland to the coal locations, and for this purpose a number of Indian packers were secured for several days. The first three weeks were spent in examining the coal outcrops at Camps Robertson and Wilson. The former of these is situated about eight miles northwest of Skidegate harbour, the trail taking off inland at the mouth of the Honna river, which is about four miles west of Skidegate post office (oil works), the Indian village being rather more than two miles farther east. Camp Wilson is situated about eight miles north of Camp Robertson. The trails were bad in places, the country being very rough and hilly. Several large seams were found; the shafts and tunnels, made some years ago, were

pumped out, and the area was carefully studied in order to arrive, if possible, at some definite conclusion as regards the actual structure of the district. The details of this work will be published in the regular report on the resources of the island, now being prepared.

It was found impossible to force a way across the centre of the island from these camps to the head of the Masset inlet and we were, therefore, after finishing our investigations on these coal seams, obliged to return to Skidegate. Here, after some delay, a fishing boat was secured, and though no one could be found who knew the western coast, and though the chart of this part of the island was practically worthless as regards details, we started from the village by way of Skidegate channel westward. This channel affords a passage for boats at high water only, and after reaching the western entrance we examined the west and north coasts as far as Masset on the north end of the island, studying on the way the so-called oil-bearing rocks south of Frederick island, and the lignite deposits of Virago sound and Masset inlet, and the coast about five miles east of the entrance.

The shores of the large lake-like expansions near the centre of the island, were examined, and here our party divided, my assistant and one man with a light canoe ascending the Yakoun river to the lake at the head (Yakoun lake), a very difficult trip owing to the low condition of the water and also to the fact that, for much of the distance, the river was obstructed by heavy log-jams. It was found impracticable to take the canoe all the way to the lake, and the party, therefore, forced its way through the jungle along the stream until it struck a trail leading across to Camp Robertson, whence they made their way out to Skidegate.

After coming back with the boat to Masset village the examination of the north and east coasts was continued, but owing to a very heavy and prolonged gale we were detained for ten days at Tow hill, through the impossibility of rounding the dangerous northeast corner of the island known as Rose point. The black gold bearing sands of the east coast were examined, and they were found to extend south from Cape Fife nearly to Lawn hill, or to within about fourteen miles of Skidegate. This place was reached on Aug. 2nd and the boat for Vancouver was taken on the 8th, that city being reached on the 13th. As there is only one boat a month to the island this was the only possible course to pursue, the stormy season setting in before we left the island.

On reaching Vancouver the party was paid off, and a couple of weeks were spent on Vancouver island in company with Dr. H. S. Poole in order to compare the coal-measure rocks of the Nanaimo district with those of Graham island, my assistant for the season, Mr. S. C. Ells, B.A., making a trip in the meantime by way of the Nicola country to the coal fields of the Tulameen and Similkameen districts for the purpose of ascertaining their extent and value. It was found that to complete this investigation would require a whole season, and he thereupon proceeded round by way of Princeton and Penticton to the Okanagan lake where, also, coal deposits were reported. These were found to be practically of no economic importance. After an examination of this area, the party returned to Ottawa which was reached on Sept. 8th.

Leaving Ottawa on the 17th a trip was made to New Brunswick and to Nova Scotia, in order to study, with Mr. Hugh Fletcher, certain difficult points of structure connected

with the Devonian, Silurian and supposed Cambrian of those provinces. On the return trip, by the request of the Department, an examination was made of the rock formations around the town of Sweetsburg, Quebec, to determine, if possible, the feasibility of finding by boring a supply of water for that town. The return to Ottawa was made on Oct. 9th. The compilation of the map of Graham island has been nearly completed, and the general report on the season's investigation is now being written.

The Nanaimo-Comox Coal-field.

Dr. H. S. Poole.

In accordance with instructions I left Ottawa on May 10th, in company with Dr. R. W. Ells for British Columbia, and together with him visited, via Kamloops, the region about Nicola lake where coal seams have been discovered and have been of late under exploration. Dr. Ells has already reported on the structure of the Quilchena field and on what, in 1904, he was able to see of the coal beds. Since that time the work of exploration has been confined to boring with a diamond drill, and I found the condition of the old openings after the dilapidations of winter did not enable me to judge, as a mining man, of the prospective value of the deposits which are evidently widespread, but only to note outcrops of coal imperfectly exposed in a weathered condition at several places on the slopes of Quilchena creek.

Near Coutlee on the Coldwater river access was had to the coal seams opened under a rock roof where the dip of the strata is at a moderate angle convenient for working. Further prospecting there seemed necessary along the outcrop and in depth, to determine the folding of the strata.

Excavations near Enderby at the head of Okanagan lake, whence samples of coal of promising appearance had been taken were not open to examination.

On reaching Victoria the courteous officials of the local government freely placed at my disposal such information as they possessed respecting the coal fields of Vancouver island, which it was your desire I should investigate, and endeavour to obtain a history of past workings for coal, with a view to elucidate the geology and further help to form an opinion of the future prospects of coal mining in that field. Through the kindness of Mr. W. F. Robertson, the Provincial Mineralogist, I made acquaintance with many who had been, and some who were now, connected with the coal industry of the island. Mr. E. B. Mackay, the chief draughtsman, kindly supplied me with copies of all available maps of his department. These, however, seldom showed, even approximately, the country roads, so the services of Mr. Thomas Budge were called in. With a cyclometer on his bicycle, and a prismatic compass he traversed the roads and ways in the neighbourhood of the mines and the district between Ladysmith and the entrance to Nanoose bay. I was exceptionally fortunate in securing the assistance of Mr. Budge who has large local knowledge of the country and its geology, and is further a coal mine manager

by profession. Mr. Budge has also placed at the service of the Survey a collection of sections he has himself prepared from specimens of the rocks of the Vancouver series in the neighbourhood.

Mr. A. Dick, who has spent the best part of his life among the mines of this country aided me by the exercise of his retentive memory, and was as painstaking to keep me historically correct as he is zealous to require compliance with the law in his office of Inspector of Mines.

Records of several boreholes in both the Nanaimo and Comox fields were obtained through the kindness of Mr. T. Stockett, General Manager of the Western Fuel Co., and Mr. F. D. Little, General Manager of the Wellington Colliery Co., who also were good enough to furnish copies of maps.

Information was sought for data obtained in the course of prospecting and working the coal fields since they were reported on by Mr. J. Richardson in 1876-7.

Inquiry indicated that in the northern section of the island nothing further had been disclosed of the structure about Fort Rupert, Coal harbour, McNeil's harbour, &c., than what was described by Dr. G. M. Dawson in his Report of Northern Vancouver, Part B. 1886.

Mr. W. Hogan who was a good deal with Mr. Richardson in the seventies advises that prospecting on the coal measures at Gillies bay, Texada island, disclosed that the outcrop of coal seen there was only a patch, apparently on a fault.

Opposite Crofton on Osborne bay explorations were made on Salt Spring island, between the public wharf and Vesuvius bay. Two boreholes were put down in 1901 where some coal and black shale cropped vertically on the shore, one near the public wharf to a depth of 400 feet computed by the drill man 1,500 ft. over the coal. This is in line with the theoretical continuation southward of the horizon of the coal beds at Nanaimo, but the borehole record was not obtained, and general report makes the prospect unsuccessful and the ground faulted. At Koksilah in the Cowichan section an exposure of black shale reported to be coaly induced the sinking of a trial pit by Mr. Wood. The locality was not visited nor the statement confirmed that limestones in the neighbourhood, which is south of Duncans, are full of fossils.

Explorations outside the field of immediate examination, on a more extensive scale were those at Tumbo Island in 1893, when people of Victoria sank a shaft at No. 1 borehole, some 60 feet on the eastern side opposite its mid-length. Next they bored on the western side close to the water from a base blasted out of the rock, so I am informed by Mr. A. Dick. The bore reached a depth of 300 feet, having passed through bituminous shale and coal at 280 feet, the coal being so friable that a large quantity was pumped up in the bore. The channel alongside is reported to be 40 feet deep, and it was thought it gave access to the borehole. Contrary to his advice, says Mr. Dick, a shaft was sunk on the site of the borehole and this at 200 feet met so heavy a flow of water that it was abandoned, and then the 60-foot shaft was put down and stopped for want of funds. The surface on the island here slopes with the strata at 16° to the eastward.

It is of interest to prospective miners of coal in this locality to know that the grant of railway lands with their mineral rights, by the Act of 1887, does not include in the reservation the islands of the east coast of Vancouver island, and their mineral rights therefore go to the owner of the surface, with whom negotiations may be made. In the conduct of this inquiry, so far, attention was solely given to the sedimentary beds of the western littoral and no study was made of the basal rocks, the Vancouver series, of the interior, on which the coal bearing beds rest. These rocks and their metallic contents have been the special object of Mr. H. J. Sutton in the interest of Messrs. Dunsmuir & Son, the holders of the E. and N. Railway concessions, and he has travelled more among them throughout Vancouver island than any other trained observer. His collection of specimens of these rocks is unsurpassed, and he has noted, on a map of the island he has prepared on a large scale, the data he has accumulated.

The interest of Messrs. Dunsmuir & Son in much of the regions he has explored has now passed, with the sale of the railway, to the ownership of the Canadian Pacific Railway.

Besides the help obtained from government and colliery officials, information was had of private individuals, so much at least as they felt at liberty to make known ; but I found myself unexpectedly barred from some records of exploration by the view that the secrecy insisted on while borings were in progress was still binding, although necessity for reticence and private interests had long ceased. In the East the practice I believe to be this, where coal is the object of search : to regard secrecy as no longer necessary when once the information obtained is utilized, and then place at the disposal of the public all secondary details, regardless of their cost. The result is that many structural details, of no financial value whatever to the explorer, but pertinent to this inquiry and only to be had by boring, have not been secured.

In the absence of official data, and with press notices of the closing down of collieries, an impression of late was produced away from Vancouver island that the workable coals are of less extent than Ottawa and the East had been led to suppose. Now there are some people who have a vague idea that a coal mine is like a spring of water, with a flow to last at least their day, and they do not realize what 'worked out' really means. What has happened is this: Wellington, which for many years was a busy centre of trade, has ceased to have an output of coal, the openings there have been abandoned, and in their stead mines at Extension have been developed, and Ladysmith has increased its population. At the same time it is true the coal operator in Vancouver island has had many disappointments, many unexpected difficulties to meet that are specialties of this coal field, in comparison, say, with the structure of the coal-bearing deposits of the opposite side of the continent.

In Cape Breton the beds carry a fairly uniform thickness for miles. Coal, sandstone, shale and fire-clay, each occur and re-occur in their due order of deposit, while in Vancouver the records of sections taken only 1,000 feet apart read so differently that it is hard to determine which are the beds continuous in both, which have been suppressed, and which have been unduly developed within that short distance.

Many of the difficulties that meet the miner are totally apart from questions of geological consideration. There are questions of supply and demand, questions connected

with labour and questions of cost, all outside an inquiry touching the possible extent of the fields and the workable character of the coals. Active operations are at present in the hands of two corporations alone—the Wellington Colliery Co. and the Western Fuel Co. The business of the latter company at Nanaimo was suspended for some months by a strike of the miners, and the pits were closed during the time of my visit. I had, however, through the kindness of the colliery officials, opportunity to go below at both Extension and Cumberland.

Under guidance of Mr. John Matthews, manager at Cumberland, in the Comox coal field, the reported occurrence of anthracite coal was examined, together with exposures of coal altered and coked by igneous dikes on Browns river, some four miles from No. 7 slopes, which are being opened by the side of the Puntledge or Courtney river, two miles below Comox lake. At an exposure on a small water course half way between the two places a lava flow has converted some coal into a dense silvery coke. The exposure was limited, but so far as it permitted inspection the alteration extended but a short distance from the dike. From this point to Browns river the flow of andesite has made a hill 1,000 feet above the sea and capping the coal measures. What its effect may be on the underlying coal seams can only be conjectured; but neither here nor at No. 7 slopes could the coal mined be classed as in any degree anthracitic. The exposure at Browns river is above where Richardson took his No. 1 section, published in the Survey report for 1872–3, page 36; and it is opposite where the river takes its plunge in cascades through a narrow gorge of the older diabase against the outcropping sedimentaries. Mr. Matthews wrote an article on this locality in the 'Mining Record' of Victoria, November 1901.

Another unusual, close association of coal and igneous rocks occurs also in the same district, but in this case under reversed and ordinary conditions, the coal being the newer of the two. Right in the heart of the town of Cumberland, in the workings of No. 6 shaft, bosses of diabase project up through the pavement of the lowest seam at several places; there is no dislocation, the coal merely thins over them, but the contact is very close; in one case not an inch of what may have been mud intervenes between the weathered surface of the igneous protrusion and the coal. The bosses appear to have belonged to a spur from the hills; among its depressions first were deposited the grey shales and sandstones, these overlapping its sides apparently failed to complete the levelling up of the surface and so left these knobs of rock still exposed when the time came for the deposition of the coal seam. In a comparison of the conditions attending the workable seams of coal in the two great divisions of the coal field, the Nanaimo and Comox, this proximity of the workable coals to the unconformable rocks beneath in the latter division is in marked contrast with those in the former, where depths of 1,000 feet or even more of sediments, with thin coals and massive blue shales prevail.

Another important feature of differentiation between the two divisions is the association at Nanaimo of the working coals with thick beds of conglomerate, and their practically total absence in the worked portion of the Comox division.

As to the area of the coal-bearing series, it may, in general terms, be said to extend down the whole west coast of the island, but the area in which it is probable coal in workable thickness exists is very much less, while the area that may be regarded as

proved is comparatively small. The difficulties in the way of exploration are numerous; vegetation is rank, the surface is largely disguised under thick layers of wash gravels, and there are no inducements to the public to prospect over the major portion of the more immediately promising ground, as these lands are held by the present coal operators who have no occasion to explore much ahead of their requirements. Still, if it be desired that a conjecture be hazarded of the quantity of coal exceeding a thickness of two feet, and within a vertical depth of 4,000 feet, an estimate of 600 million tons, though based on most incomplete data, would seem conservative and yet at the same time sufficiently large to allay apprehensions of any immediate shortage in the output.

The fossils collected in connexion with the above geological work have been submitted to Dr. Whiteaves, palæontologist to the Survey, for determination.

The Northern Extension of the Elk River Coal Basin.

Mr. D. B. Dowling.

The season's work was mostly of a preliminary character and much of the time was employed in topographic work.

The Elk river coal basin extends north and enters the valley occupied by the waters of the Kananaskis river. The area was entered from the north by the trail up the Kananaskis river. As the outfit had been left at Morley for the winter, supplies were obtained and the party were in the field in June, but as the mountains were then fairly well covered by snow, few ascents were made until the beginning of July.

A short base of 5,685·68 feet was measured on the shore of Kananaskis lake and a series of triangles measured extending southwest down the valley of the Elk river to a point twenty-eight miles distant from the station at the north end of Kananaskis lake. A check was then made on another base of two miles in length along a surveyed line forming part of a series of lines limiting the coal properties of the Elk River Coal and Oil Co. Four monuments or signals were built on the summit of the Elk range, which here forms the watershed, so that the triangulation might be carried eastward to embrace the coal basin within the mountains on the headwaters of Sheep creek and Highwood river. Photographs from which to plot the topography were taken at each station and several at other points which seemed desirable. As the transit used could only be read to single minutes it is very desirable that a primary triangulation of this area be undertaken by the government in order to better fix the positions of our stations. Our triangles, it is expected, will be extended east to meet the surveyed lines of the plains, but this entails the use of time which we can better devote to the geological problems before us. At the close of the season's work a few photographs were taken in the lower part of the Kananaskis valley to supplement the work of the previous season on the southern extension of the Cascade coal basin which was interrupted in September, 1904, by a period of smoky weather.

A general sketch of the structure of the region was obtained and may briefly be given. The southern extension of the Cascade coal basin does not reach very far south of the crossing of the Kananaskis valley. The impression which was formed from seeing the section on the stream the previous year was that the Cretaceous rocks formed a monoclinal block which gradually ran out to the south, but further evidence shows that this block was deformed by the west to east pressure, and, instead of having the western edge of the beds drawn up by the faulting, an anticline which broadens out to the south is found in the centre, so that the section on a small stream a few miles farther south reveals a double syncline and the beds become very much shattered. The base of the formation rises to the south and in a short time disappears, continuing possibly in two narrow folds the continuation of the synclines.

As the intervening mountains are not thoroughly explored it is not sure whether these folds can be traced as continuations of the beds crossing Elbow river and the northern end of the Sheep Creek coal area.

The Kananaskis valley in the upper part is a continuation of the same structural valley as that in which the Elk runs. To gain the eastern edge of the mountains, however, the valley is eroded through several limestone ranges crossing the first obliquely, but in the lower part more nearly at right angles. The southern end of the Cascade basin is thus cut by the river at about 45 degrees.

The upper valley is eroded along the edges of Cretaceous rocks, but very few exposures occur until the height of land is reached, and more are found in the valley of the Elk showing coal seams at several places. The mountains forming the eastern wall of this valley are practically continuous exposures of the same series of beds—the upper part of the Carboniferous limestones which dip west toward the valley. They form an unbroken wall from opposite the Kananaskis lakes southward for about fourteen miles where they become broken up into isolated peaks. Side valleys run into the range from the west but not far enough to form passes through to the waters of the Highwood. On the west side of the Elk and Kananaskis valleys there is a decided fault by which the limestones below are again brought up, but instead of forming a continuous wall as is on the east side considerable lateral movement has taken place since the break occurred. These beds have several strong folds which run oblique to the line of fault, and one of them running northwest towards the Spray river with apparently a fault along the eastern edge forms a strong valley. In this there seems a possibility of a narrow Cretaceous trough extending in that direction.

In the vicinity of the Kananaskis lakes the mountains west of this fault have been eroded back from the fault line and both lakes lie to the west of it. The stream leaving the lower lakes runs north along the strike of the rocks and then turns east. Where it joins the valley common to this stream and the Elk, it falls about 30 feet in a cascade over the quartzites, which appear again on the flank of the mountains on the east side of the valley. Sandstones of the coal measures are exposed a few miles below the falls but not along the stream. It is not expected, however, that coal in any amount will be found on the Kananaskis below the falls, and but few seams in the valley until near the height of land.

On the Elk, however, there is a wider portion in which the coal bearing beds are exposed and many seams have been opened up by prospectors for the Elk River Coal and Oil Co. The only seam that we found on the Alberta slope is in the middle of the valley just north of the height of land. There seemed to be about eleven feet of coal very much broken up on the outcrop exposure, but possibly of fair quality beneath. The Elk rises in two lakes in the mountains on the western side of the valley, similar in origin to those at the head of the Kananaskis river. These are fed from a number of glaciers on the slopes of the higher range behind and the stream which leaves the lake is often very milky during the warmer months. The valley has been well forested but large areas have been burnt over and the trails badly blocked by fallen trees. It seems to be in precisely the same condition as described by Dr. Dawson in 1884, the dead trees apparently standing for a long time before the roots rot sufficiently to cause them to fall. In the unburnt portions the forest is vigorous and there is a large quantity of splendid fir.

PROGRESS IN DEVELOPMENT WORK AT MINES.

At Canmore new workings are commenced in the Sedlock seam. As the outcrop is near the river and about a mile below the mines, this means the opening of a new mine and a spur of railway is built to it. The output will be thus increased, as the facilities for handling coal at the present slope do not admit of much increase there. As some of the seams which produce a large percentage of fine coal have also sandy streaks in the softer parts experiments in the cleaning of this fine coal has led to the installation of a washing plant which will be in operation this season, and the output in consequence will be of an excellent grade. Another seam above those now worked, called No. 6, is being tested, and, if of good quality, will add materially to the resources of the property.

Bankhead Mine.—During the year most of the permanent working plant has been installed. A battery of boilers with wide grate surface, to burn small coal, supplies steam for air compressors, dynamos, steam engines, &c. A large coal breaker and screening house has been erected and the temporary screens at the entry on B. level are probably removed.

In the mine the work so far has been mostly in excavating gangways on three levels and a cross entry on the lower or A. level. A rough approximation of the amount of preliminary work is given below. On A. level the entry along seam No. 2 reaches to 1150 feet from a point below the temporary entry. A tunnel through gravel on this level in the opposite direction reaches the river bank at the head of the spur from the railway where the shops, coal breakers, &c., are located. The cross entry at 45° to the strike of the measures is over 900 feet long and cuts 640 feet of the measures which are above seam No. 2. In this distance three strong coal seams are cut. Workings on a crushed seam spoken of last year as No. 3, are abandoned and it is now called No. 2½. Nos. 3, 4 and 5 appear to be valuable seams. The workings on No. 3 extend about 500 feet and on No. 4 an equal amount. On No. 5 preliminary work only has been started. From No. 4 a manway up the slope 500 feet to the surface is used for ventilation. B. level, 186 feet vertically above A. level, was opened from the slope of the hill as the original entry. On this the workings extend to a greater distance than on the others.

On No. 1 seam the gangway is 1,900 feet, on No. 2 seam the gangway is 2,760 feet, on C. level which is 192 feet above B. level No. 2 seam is opened by a gangway 800 feet in length.

As the coal in seam No. 1 is split up by a great number of slaty partings the mining of clean coal is difficult and is discontinued, but a long slope is being constructed along it to connect the different levels. The mining on each slope will be independent of the others and the loaded cars will be lowered down the slope to the first level.

As the coal is very tender much small coal is produced. Some of it can be used under stationary boilers but as there will be a large percentage of dust briquetting, will probably be resorted to. In this connexion it seems that a market for the small coal should be looked for in the production of power by the gas producer. In plants using lignite the efficiency can be increased by the addition of anthracite, and even the small anthracite, where it can be got cheaply, produces a good water gas that gives a high power result.

The Foothills of the Rocky Mountains South of the Main Line of the Canadian Pacific Railway.

Mr. D. D. Cairnes.

Having, with my assistant Geo. S. Scott, made the necessary outfitting arrangements at Morley we commenced making, according to instructions, a geological section along the Bow river from Cochrane to the limestone mountains just west of Kananaskis station. After finishing this we started work on the district to the south, using the Canadian Irrigation Surveys 'Topographical map of a Portion of the Foothills Region' prepared by A. O. Wheeler, as a base for our topography, making such corrections as were found necessary. My instructions were to study the geology of the region covered by this map, to place the same upon it as accurately as possible and to pay special attention to any minerals of economic importance. In addition to fulfilling these instructions a considerable time was devoted to collecting fossils and quite an extensive collection of plant remains and invertebrates was made, but owing to lack of time and the scarcity of fossils in some horizons, this part of the work was conducted at a considerable disadvantage.

BOW RIVER SECTION.

This section was made partly for correlation purposes, partly to ascertain if the coal measures seen to the south did not outcrop also along the Bow river, and partly in view of the fact that conglomerate appears in several places along this part of the river, somewhat similar in appearance to that overlying the measures to the south, which are now known to extend from a few miles south of the Bow to south of the Oldman river.

The conglomerate beds seen on the Bow river below the Kananaskis falls, very prominently at the Morley agency, and on a bend in the river two miles below, are part of an intercalated sandstone series in a dark shale formation resembling the Pierre, but in which have been found quite a number of Benton fossils. Specimens of *Cardium*

resembling C. *Speciosum* are very plentiful in this sandstone series and on this account Dr. Hector in 1858 called the whole shale series the 'Cardium Shales.' The sandstones are about 200 feet thick near the mountains on the Bow river and are somewhat above the centre of the shales which are here about 700 feet thick. Below these Cardium Shales is a sandstone formation carrying fresh water shells and corresponding to the flathead beds farther south. This is about 900 feet thick on the Bow and is likely the Dakota, so that the Kootanie coal measures seen to the south, just east of the main Rocky escarpment and capped by conglomerate, are at a considerable depth below the conglomerates seen along this portion of the Bow. The intercolated sandstones above mentioned become thicker towards the mountains and along the Bow are thicker than noticed elsewhere. They consist of three distinct beds, each varying from a few feet up to 60 feet, and separated by dark shales. One or more are capped by a conglomerate of varying degrees of fineness and colour, but quite different in appearance from that above the Kootanie formation.

At the mouth of Jumpingpound creek, Edmonton sandstones and shales have a slight easterly dip of 5° to 10°. East of this to the end of the section the formation has a lower dip, becoming almost flat south of Cochrane station, where the rocks are Upper Laramie or what Dr. G. M. Dawson called the Porcupine hills series.

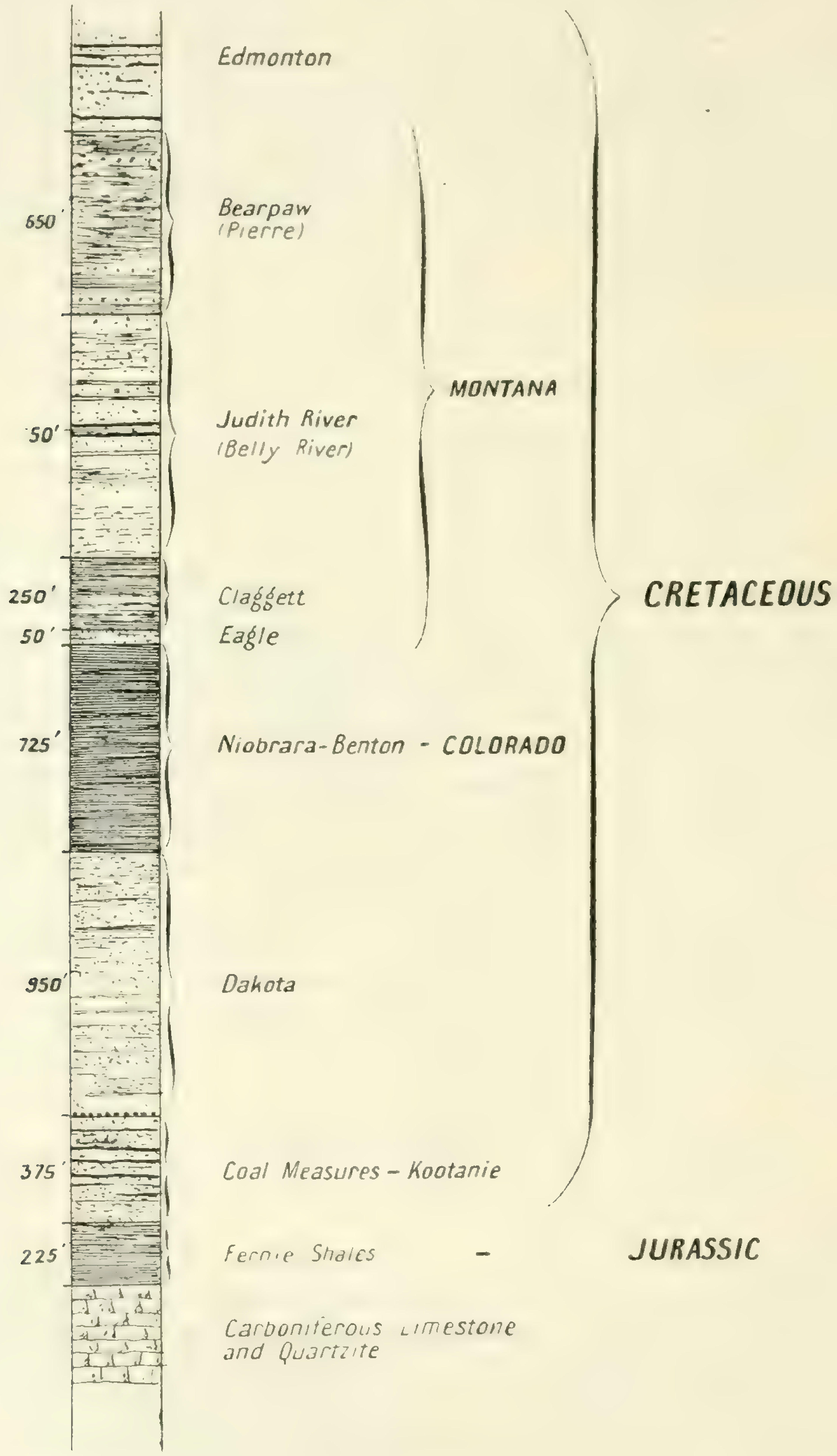
West of Jumpingpound to the mouth of Coal creek, the Edmonton rocks continue to dip east quite regularly, increasing the angle of dip to about 28° just east of the mouth of the creek. For about a mile west of here the rocks show considerable disturbance, exhibiting a series of folds accompanied to some extent by faulting. Thence to about two miles west of Morley bridge, a distance of approximately 15½ miles along the river the dips, as seen in the river banks, are, with only slight exceptions, all to the west; as the horizons are becoming lower this may, at first, appear strange, but the change is caused by reversed folding. Some faults were noticed west of Coal creek but they are only of minor importance and are thrusts with eastern downthrow of only a few feet.

The rocks at Coal creek, carrying the coal, are undoubtedly near the base of the Edmonton. From here west to Ghost river the rocks are all Edmonton, with the exception of a couple of exposures of Pierre-Foxhill; but for 2½ miles west of this the formations are very much folded and intermixed. Three exposures of Pierre outcrop and in between are interbanded Edmonton, Pierre and Foxhill rocks, consisting of light coloured sandstone beds frequently interbedded with dark Pierre shales. At a bend in the river 3½ miles west of the mouth of Ghost river, the first of the conglomerates, above referred to, appear. These, with the shales above and below them, occupy most of the valley bottom to within about a mile of the Palæozoic rocks, west of Kananaskis. Judith river sandstones are seen in a couple of places and overlie them next the mountains.

The sections as seen on the river, and in the hills to the north and south, vary greatly. This is particularly so from the mouth of Ghost river to Coal creek. In the river banks the strata all dip towards the west, while in the hills the dips vary from flat to east, forming part of a large anticline extending from the limestone west of Kananaskis to the mouth of Jumpingpound creek. The sandstones are not as liable to be folded as the softer, more pliable shales, and, consequently, the upper part of the anticline is regular, while the inner and lower part is folded and pushed over

South of Bow River.

By working south of the Bow river, and especially in the area around the Moose Mountains, our expectations of finding the Lower Cretaceous, and thus having a section in the foothills of Alberta from the Carboniferous to the Laramie, were realized; the Moose mountains forming an anticlinal ridge, or rather a qua qua versal of Palaeozoic



Section of the Cretaceous, South of Forgetmenot Ridge on the North Branch of Sheep River, Alta

strata, having Fernie shales overlain by Kootanie rocks lying on them and dipping away on all sides. Just west and south of this ridge is another, the Forgetmenot ridge, narrower and less prominent than the Moose Mountain ridge, and formerly mapped as being connected with it, but at their closest points they are separated by about 1½ miles of Cretaceous and Jurassic rocks. This latter ridge is not as regular as the more easterly one, being faulted nearly its entire length along the eastern side, and thus overlying the Cretaceous for this distance. But along its western edge, and at the north and south ends, the Kootanie formation and Fernie shales are exposed. Thus, these two ridges afford an excellent opportunity for studying the Cretaceous, a complete section being exposed, commencing with the Kootanie and passing up within a few miles into the Edmonton. The thickness of these Cretaceous beds was estimated in several places, an average section being obtained just to the south of Forgetmenot ridge, on the north branch of Sheep creek.

The Edmonton is chiefly a brackish-water formation, consisting of frequently alternating, light coloured, soft, sandstones, clays and shales, usually fairly well bedded. This formation, which forms the top of the Cretaceous, becomes harder towards the mountains and contains a number of workable seams of good lignite.

The Pierre-Foxhill is a marine formation, consisting chiefly of dark gray to brown, and even nearly black, shales of very uniform appearance. They contain numerous layers of ironstone bands and nodules, and a few beds of soft, light-coloured sandstone.

The Judith River or Belly River is a fresh water and brackish formation, consisting of light-coloured sandstones, clays and shales. It is very similar to the Edmonton, but is, towards the mountains, harder and somewhat finer grained; contains abundant remains of tree trunks, twigs, leaves, &c., but very few invertebrate remains. White, cross bedded, and somewhat massive, sandstone beds are quite characteristic of this formation. Ironstone nodules, often of large size, are of frequent occurrence.

Below the Judith River formation are the marine shales, called by Dr. Hector the *Cardium Shales*. The upper part of this formation consists of dark clay shales of very uniform appearance, and much resembling the Pierre. Below these come the sandstone series and conglomerates above mentioned. These are followed by more dark shales similar in appearance to the first and also resembling the Pierre, but are in all probability Niobrara-Benton. The three divisions of this shale series stratigraphically correspond, respectively, to the Claggett, Eagle and Niobrara-Benton formations.

Below these is a sandstone formation, somewhat brightly coloured near the top but becoming darker and very hard farther down. At the bottom, however, is a conglomerate bed from 10 feet to 40 feet thick, capped by a white fine grained quartzitic sandstone, generally about 20 feet thick. Dark blues and greens are prominent colours, especially near the top, and here there are also a few bright red bands about 2 feet wide. Fresh water shells are found near the top, and numerous plant remains were found throughout the formation. These rocks are much darker, finer grained and harder than those of the Judith River or Edmonton, and are probably Dakota.

Immediately underneath the Dakota conglomerate is usually a coarse dark sandstone bed from 10 feet to 30 feet thick. Below this are dark shales, sandstones and

coal seams, followed by a very prominent brown sandstone bed 30 feet to 75 feet in thickness. These comprise the *Kootanie* of the foot hills, which is considered the base of the Cretaceous in this district. There are numerous reasons, however, which will be given in the detailed report, for considering the Kootanie to be Jurassic.

Next below the Kootanie are the *Fernie Shales*. The upper part of these consist of brown sandstone and shales, gradually changing into very fine-grained, closely bedded and almost black shales, which constitute the greater part of the formation. From fossils found it is now certain that these Fernie shales are Jurassic.

Only a few of the fossils collected this season have as yet been examined, so the results of their determination will be given in the final report.

GENERAL GEOLOGY.

Along the eastern side of the mountains the contact between the Palæozoic rocks and the Cretaceous is a faulted one, with eastern downthrow. East of this lies that portion of the foot hills described in this report. Enormous and long continued pressure from the southwest has caused the geology of this district to be, in places, very intricate, the rocks being all more or less folded, and the folds usually pushed over and often faulted. The high rugged limestone ridges, the Moose and Forgetmenot, somewhat to the west of the centre of this area, are the most marked results of this pressure here, and have added much to the complexity of the formations. The Cretaceous strata were upraised around them on all sides, and after long periods of erosion they now appear with upturned edges high up on the limestone hills; with the exception that along the eastern edge of Forgetmenot ridge the pressure has been too great and the fold has broken, causing the limestone to overlie the Cretaceous rocks in a similar manner to that of the contact east of the main Rocky Mountain escarpment.

For the final report, east and west sections are being prepared; these are intended to explain such irregularities. One is along the Bow river, where the formations are uninfluenced by the Moose mountains. One is approximately along the Elbow river through Forgetmenot and Moose ridges, and another is just south of Forgetmenot ridge. This last is probably the most complicated, showing as it does the close, reversed, and somewhat distorted folding of the Cretaceous rocks over the limestone, which takes the place of the long fault on the eastern side of the ridge where the limestone overlies the Cretaceous.

COAL.

In a few places thin layers of coal and carbonaceous matter occur near the base of the Pierre, but no coals of value were noticed on this formation in the district examined this season.

Lignites, which are, as a rule, of very good quality, were found in a number of places in the Edmonton and Judith River formations. Workable seams were seen at several places along the Bow river west of Cochrane and on the Morley reserve south of the river. There are also workable seams on Jumpingpound creek, N.W. ¼ sec. 19, tp. 25, r. 4; on Bragg creek, sec. 7, tp. 22, r. 5; on Fish creek: N.W. ¼ sec. 7, tp. 22,

r. 3 ; N.E. $\frac{1}{4}$ sec. 4, tp. 22, r. 3 ; S.W. $\frac{1}{4}$ sec. 21, tp. 22, r. 3 ; south branch of Sheep river : S.W. $\frac{1}{4}$ sec. 29, tp. 19, r. 4 ; S.E. $\frac{1}{4}$ sec. 30, tp. 19, r. 4.

Those seams on the Morley reserve, on Jumpingpound creek, and on the south branch of Sheep river are the best, according to analyses, and surface indications.

The Kootanie coal measures extend all around the Moose Mountain ridge ; along the west side of Forgetmenot ridge ; from 'Gleason's Meadow' along the east side of the ridge through 'Gleason' and 'Lower Camp' ; along the northwestern and eastern slopes of 'Coxcomb' mountain, near its summit, and thence to the north end of Forgetmenot ridge ; on Jumpingpound creek, north of Coxcomb mountain ; on the south branch of Sheep river, north of 'Hoffman'; and in a few other places as shown on the map to accompany the report of this district.

The measures vary somewhat in thickness, amount of coal, and number of seams. Sections of the Kootanie were measured in a number of places outside the mountains and were found, in each case, to contain 3 or 4 workable seams and a total of from 22 feet to 30 feet of coal. One section measured just inside the mountain, near the head of the south branch of Sheep river, was found to contain over 40 feet of coal. There may, however, be more coal than was seen, as our work was chiefly to locate the measures, so that persons looking for coal will only have to prospect along them for places where the coal is best and most accessible. In my final report will be given details in regard to all coals seen, in the Edmonton, Judith River and Kootanie formations. Sections of measures, widths of seams, quality of coal, analyses of average samples, accessibility, &c., will be given, for which there is not space in this summary report.

Conclusion.—The Kootanie formation which was formerly supposed to exist only within the mountains, has been found in the foothills, carrying valuable coal measures. The formation and measures are much thinner here than within the mountains, showing the improbability of their extending eastward past the disturbed area of the foothills. They should, however, prove of considerable economic importance, particularly, as the measures are quite accessible up most of the rivers and streams of the area, which cut through them, flowing eastward from the Rockies.

The lignites, while not of as good a quality as the coals of the Kootanie, are still very good lignites and, as a rule nearer a market, often more accessible, and will become an important asset to the district.

The Surface Geology of Manitoba, Saskatchewan and Alberta.

Dr. R. Chalmers.

The winter of 1904-5 was spent in the office in routine work and in preparing a bulletin on the clays of Canada. In collecting the material for this bulletin it was found that the data from the west were meagre and incomplete. It was, therefore, considered advisable to postpone publication until more information was obtained from the new provinces. Meantime I was instructed to make such an examination of the surface geology of these provinces, and of all matters relating thereto, as was possible.

I left for Winnipeg on the 16th of June. The first two or three weeks were spent in the vicinity of that city, and in examining the country southward to the International Boundary, northward to Winnipeg and Manitoba lakes, and eastward and westward to the province boundaries. The eastern part of Saskatchewan as far south as Estevan, also that part north of the main line of the Canadian Pacific railway were next traversed, after which I proceeded to Regina and from there examined the plains northward to Prince Albert, southward a considerable distance, and westward to Moose Jaw. Going west from Moose Jaw to Calgary the latter place was made my headquarters for some weeks, and the whole surrounding country south of the North Saskatchewan river and west to the Rocky Mountain divide was traversed. The work here proved to be of great interest. Numerous exposures of the surface beds were examined, especially along the river banks, and in gravel pits, brick yards, etc. Good sections were obtained in a number of places, showing the character and succession of the beds. The scenery of the Rocky mountains here has been so frequently described that it need not be referred to; but the tremendous erosion which these mountains have undergone seems to have been but little commented on. Yet an observer looking at the trenching and denudation which these mountains have suffered must acknowledge that it is to them that the thick beds of gravel, sand and clay now occupying the plains to the east are due.

These plains are in reality the northern extension of the Mississippi and Missouri valleys, and the surface beds underlying them appear to have been similarly formed on both sides of the International Boundary. Two boulder-clays were everywhere noted. These have a thick interglacial series of sands, silts, gravels and clay. The boulder-clays, so far as examined, do not occur in continuous sheets, but in lenticular, detached masses. The two were observed, one above the other, in the same sections in the Bow and Belly valleys, and in a number of other places to the east.

The transported boulders found on the plains seem to have been largely derived from the boulder-clay of the second glacial period by its denudation. Those belonging to the Archaean rocks are found scattered everywhere, nearly to the base of the Rocky mountains. Their presence on the higher levels has not yet been satisfactorily explained.

During the second week of September Medicine Hat was visited, and a day or two was spent in securing a section of the surface beds there, and in obtaining the facts relating to the gas wells. Information was kindly given me by the manager of the gas company. The town is lighted and heated by natural gas and owns the wells and plant. On leaving Medicine Hat I returned directly to Winnipeg. From this city Birds Hill, Deloraine, Turtle mountain and Napinka were visited. Turtle mountain, like the other mountains of the prairies, is chiefly morainic. Afterwards I went out to Dauphin, Gilbert plains, etc., and examined Riding and Duck mountains, Returning to Winnipeg a trip was then taken to Fort Frances where a large peat bog occurs, on which a new peat plant has just been set up. Brick works are also in operation here. Thence I went to Port Arthur, returning to Winnipeg on the 1st of October. After examining some places north and east of Winnipeg, not previously visited, I left for Ottawa, reaching there on the 7th of October.

Brick clays are common in Manitoba, Saskatchewan and Alberta, and large quantities of bricks are manufactured at or near the principal towns. Pressed bricks also are now coming into use, and in a few places these are being made. Tile is very little used, but the clays are quite suitable for its manufacture.

The Region South of Cape Tatnam, Hudson Bay.

Mr. W. Stewart Dobbs.

In the month of July I was instructed by Dr. Bell to make a geological reconnaissance of the region lying southward of Cape Tatnam to the eastward of York Factory on Hudson bay. From a point seventy or eighty miles due south of this cape the streams radiate in all directions, and the district around it was described and represented on the maps as being considerably more elevated than the extensive level country surrounding it. It was supposed that this physical condition might indicate an area of older rocks than the unaltered and nearly horizontal limestones of the low country, especially as such areas have been proved to exist at Sutton Mill lake, southwest of Cape Henrietta Maria,* and on the Winisk river.† The existence of a large area of such rocks would constitute an important feature in the geological map of the Dominion and it might be expected to possess economic value from containing metallic ores.

It was thought that the best way of reaching the district in question was to proceed to the Shamattawa river and ascend one or more of its branches flowing from this area.

My instructions also directed me, in going to this ground, to follow for a part of the distance a different route from any of those which had been already explored by Dr. Bell himself in 1878, '79 or 1900, or by his assistant, Mr. A. S. Cochrane, in 1879. I was to make track surveys and geological examinations of these routes, so as to add to our previous geological and topographical knowledge of the country. I was also to make copious notes on their physical features, their forests, fauna and flora, and of all other matters which might some day prove of interest.

In accordance with these instructions I proceeded, via Lake Winnipeg and Norway House, to Oxford House, where the final arrangements were made for the long canoe voyage ahead.

With Mr. Moir, of the Hudson's Bay Company, I left the route usually travelled and proceeded to Gods lake, by way of Back lake, Trout river and Knee lake, to the mouth of Wolf river (Meachan sipi), thence up Wolf river (with three portages) to Swampy portage lake, over the Swampy portage to Gods lake, and on to the Post on its shore. The Indians told me Swampy portage was comparatively dry, still one sank to the knees in the sphagnum moss at every step.

We reached Gods lake post Saturday the 12th and left Tuesday August 15 for the Manitou sipi, or Gods river, a journey of about twenty-three miles, including five rapids, the Red Fox, White Teeth and the three Ogema rapids.

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*See description by D. B. Dowling in the Summary Report of the Geol. Survey for 1901.
†See Wm. McInnes' description in the Summary Report for 1903.

The country passed through is very rocky, with thin coverings of soil. and is only sparsely wooded. The Manitou is a large, rapid river about 220 miles long following its course to its junction with the Shamattawa, near the Deer Lodge winter post of the Hudson's Bay Co. Progress down the river was comparatively easy on account of the assistance of the current. The waters of the Manitou river teem with sturgeon, trout and pike, while in the valley there are ducks and geese. Of the fur-bearing animals foxes are the most numerous. Below the junction of the Red Sucker, the Manitou becomes wider and swifter, with banks of white boulder clay or till about 80 feet high. Rock exposures were infrequent aud finally disappeared beneath an overburden of drift material.

During the entire journey from Gods lake to the Shamattawa, I saw only four camps of Indians, made up of about nine tepees and tents, covering sixty souls, men, women and children.

The clay banks kept rising until, at their highest, within the last sixty miles, they presented nearly ninety feet of white till that had been cut into by the river. The nomenclature of these rivers, according to the present Indians, does not correspond with that of the maps. The Shamattawa, according to the latter, includes part of the Shamattawa proper and sixty miles or so of the Manitou or Gods river and Red Sucker river. The Manitou river flows from Manitou or Gods lake into the Shamattawa. The Red Sucker runs into the Manitou about 60 miles southwest of this junction.

Hereabouts are 25 miles of rapids ending in the Mistassini powistik or Big Stone rapids, the water rushing over and foaming around gigantic boulders. After passing this rapid, the river becomes broad and deep, with here and there a few small rapids, until the Limestone rapids of the Shamattawa are reached. The country abounds with life, both feathered and furred. We saw abundance of coloured foxes, and mink was very common. Every marsh or weedy bend in the river sent up its quota of ducks on our opproach and several times later in the season we saw large flocks of wild geese moving southeastward. The river teemed with fish, principally young sturgeon, speckled trout and pike. One reach, nearly twenty miles long, near Puskajewan, is an ideal place for the breeding of wild duck.

We pushed up the Pekano river, struggling against shallow water and a strong current, in cold, rainy and foggy weather. The Pekano is a river from about 60 to 300 feet broad, with a current varying from four to seven miles in some places. No outcrop of rock was visible at any spot in the whole 130 miles of its length that I travelled, at which distance the river became so shallow that it was impossible to follow it farther.

The country from the Shamattawa river east was undulating and on an average of 75 feet above the river valley, which was about two miles across. The banks were all drift material, clay, boulders, stones, &c., and the country was monotonous in the extreme. Mile upon mile, as far as the eye could see, the country undulated to the horizon line. It was sparsely wooded with a stunted growth of coniferous trees, constituting a hopeless tangle of fallen and half-fallen trees, relics of the numerous forest fires that have taken place throughout this region, with ravines here and there where small streams cut their way to the river. Mosses and lichens cover the ground wherever

there is a breathing space. A few stunted bushes, including the Labrador tea, were all that was necessary to complete a picture of desolation. At the end of the navigable part of the river, the ground became fairly flat with a slight downward slope to the northeastward.

After examining both sides of the river valley as thoroughly as time would allow, and searching the river bed for any possible clue that would lead to finding an outcrop of rock, I decided, in the absence of any rising ground, to abandon this part of my trip. No fossil-bearing erratics were found on the river over fifty miles from the Shamattawa, while fossils were very abundant in the pebbles and stones within that distance.

By this time—the end of August—the weather had turned bright and cold, and we had severe frosts every night; we returned to the junction of the Shamattawa and Manitou rivers with one canoe in a very leaky and frail condition. On the Shamattawa we were again overtaken by bad weather—rain, fog and wind from the northeast: the woodland cariboo were crossing the river in droves, and this enabled us to lay in a good supply of fresh meat, in addition to which we killed geese, duck, sturgeon, whitefish, &c.

It was too late in the season to look for outcrops south of the Pekano river. I, therefore, decided to retrace my steps to Norway House in order to catch the last steamer. The weather, which had been bright and cold for a couple of days, now began to get insufferably hot.

From Big Stone rapids on to Gods lake post we had strong head winds, and this, with the currents and rapids, made our progress difficult. We reached Gods lake post on September 12th, after a very rough passage from the mouth of the river, the waves running very high. At the post there was much talk about a cinnabar deposit, distant a day's journey, but in which direction nobody seemed to know.

Mr. Hyer, of Winnipeg, the trader in opposition to the Company, has a gold location on Island lake near Manitou lake, and samples of ore, stated to have come from there, were very rich. On the return journey, on the Echamamish, I came across an interesting occurrence of molybdenite at a contact between rocks of a gneissoid character with an intruded plutonic rock.

After waiting six days at Norway House we started for Warren's Landing, and arrived in Ottawa on October 16th.

Pursuant to instructions, I carefully noted the forest growths and burnt areas, and beg to submit the following notes:—The woods from Norway House and on up the Echamamish were very young, none of the trees appearing to be over fifteen years old; in some parts the fires have been quite recent, and, indeed, in several directions, we could see heavy clouds of smoke. The season had been very dry, and these fires must have created great destruction among the forests.

The forest in the neighbourhood of the Robinson portage was denser, and the trees seemed to be, on an average, from 15 to 30 years old. The same condition of things was noticed down to Oxford lake. All along the north shore of this lake fires could be seen, and about three miles northwest of the Hudson's Bay post a huge fire was raging and continued to burn, it is said, for nearly three weeks.

From Oxford lake on to Mossy portage the forest growth was very young, and gave abundant evidence of at least one recent burning. At Gods Lake post Mr. Swain showed me some fairly large timber that came from 'down the bay.' Some of the trees must have been forty-five years old. On entering the Manitou river three-fourths of the region from the lake to the Red Sucker river has been burnt once at least in the last ten years.

From the Red Sucker rapids to the Shamattawa rapids occurs some heavy forest growth; young trees from ten to fifteen years, and some fine groves of trees about twenty-five years old. In some districts that have not been burnt, the trees are so densely crowded that they are dying of some rot disease, the effects of too little sun and air. They are being literally smothered to death. The forest growth is largest and thickest along the courses of the streams and thins out away from the river banks.

The conditions are the same on the parts of the Shamattawa that I travelled, and the trees show a decided tendency to fringe the river banks. At the junction of the Shamattawa and the Pekano, on the east bank of the Shamattawa, is a remarkable grove of large trees. There were several stumps with a large number of rings—one with 53 rings, one with 63, and one with over 76. This grove was the best that was noticed in my travels.

The Pekano is fringed with willow bushes, interspersed with long grass, backed by two or three kinds of small coniferous trees, with a few small birches and two species of poplar, the trembling leaf and the rough bark. The country here has been burnt over at least once in the last ten years, and in some places there are evidences of previous conflagrations. The conifers, therefore, have not attained a growth of ten years, while the birches, poplars, &c., average about six years. Of course, there are a few isolated places where the forest growth has attained to a larger size; and I counted four groves, besides the one mentioned above, of about fifty trees, with ages varying from 23 to 42 years.

The country away from the river valley is a vast, slightly rolling plain with burnt sticks standing up like hop poles or lying in an indiscriminate tangle on the ground, with young forest growth springing up among them.

The frequent burnings are nearly always due to the carelessness of the Indians. Several times our party has put out fires that started from unextinguished camp fires.

There is no reason why most of this region could not, if protected from fires, produce larger trees which might be of great value to the country in the future. The institution of a Forestry Department would be of great benefit to the country, especially to the particular area now referred to, and the Indians could be made most useful forest rangers.

The Pekano is, practically, one pebbly rapid from source to mouth, and from what I could find out there is no rock outcrop anywhere in the country drained by this stream, or to the northward. I have already referred to the Limestone rapids at the junction of the Shamattawa and Manitou rivers. For about forty miles up the Pekano the pebbles were nearly all of limestones and I succeeded, with difficulty, in finding a couple of pieces showing characteristic fossils.

It is not until the Mistasini rapids are approached that any rock exposures are seen. At that point a pinkish acidic plutonic rock occurs, extending over twenty-five miles.

The rocks of the Manitou river can, for convenience sake, be divided into three classes :—an acidic igneous complex, which seems to be the basement of the rocks in this district ; a conglomerate with associated schistose rocks at Goshabisk rapids ; and, lastly, dark basic rocks occurring in some places in considerable masses and in others as dikes. The last named rocks are certainly younger than the acidic igneous complex and they sometimes cut the sedimentaries.

The light-coloured gneissoid, acid rocks occupy by far the largest area and appear in several parts of the river valley, where they are intruded by the younger basic series. They are generally composed largely of quartz, with orthoclase, some albite, mica, hornblende and magnetite. The rock is granular in texture, and shows in parts distinct curved jointing. In some cases it shows very little quartz, and practically may be classed as syenite gneiss.

The only sedimentaries observed were the metamorphosed conglomerate, showing great distortion of the included pebbles, which appeared to be composed chiefly of rocks of the granite family, derived from the underlying gneissoid rocks, with a few quartz pebbles. The matrix of the conglomerate is distinctly schistose in character, resembling a chloritic schist. These sedimentaries dip at an angle of 18° and strike N. 70° E. In these schists near Goshabisk rapids are small veins of calcite with hornblende, carrying pyrrhotite, pyrite and chalcopyrite.

Farther to the southeast is a large outcrop of dark greenish-gray igneous rocks, which are again succeeded by gneissoid rocks. The basic igneous rocks are composed for the most part of feldspar with large proportions of hornblende and pyroxene. In places, isolated outcrops of this rock are decidedly schistose, with distinct jointing in two directions. These rocks, as at Bell rapids, are seamed in all directions with veins of quartz varying from a fraction of an inch to six inches in cross section.

Owing to the heavy burden of glacial drift material, the rocks in this district cannot be studied over any great area. My limited time and the difficulties of transport prevented me from examining them in detail.

A Survey of the Coast of Hudson Bay from York Factory to Severn River.

Mr. Owen O'Sullivan.

In accordance with instructions authorizing me to survey and explore the southern coast of Hudson bay, I proceeded on May 5 last to Winnipeg, where I procured my outfit and laid in all the necessary supplies for the expedition. Mr. Jos. de Lorimier acted as my assistant. We left Winnipeg on May 27, arrived at Warrens landing on June 1st and reached Norway House (the Keewatin headquarters of the Hudson's Bay Co.) the following day. Mr. Donald McTavish, the officer in charge, received us very kindly and supplied us with four of his best Indian guides for our trip to York Factory.

We left Norway House on June 5 taking the canoe route *via* the Hayes river which was surveyed by Dr. Robert Bell in 1877. This canoe route is the well known highway between Hudson bay and Lake Winnipeg and has been travelled by Indians, early pioneers and officers of the Hudson's Bay Co., for centuries.

Owing to an exceptionally light snowfall during the winter and very little rain in the spring, it was only with great difficulty that we got our loaded canoes down the shallow rapids.

Ice and snow were occasionally seen in the ravines and where drifts had accumulated during the winter.

We arrived at York Factory on the 18th of June. This Hudson's Bay Co.'s post is situated on the north bank of the Hayes river about five miles from its mouth.

For a week after our arrival, the ice from the bay was carried by the tides up and down past the post, preventing us from starting eastward on our work; during this delay several astronomical observations were taken and occasional runs were made inland.

Mr. Boucher the officer in charge of York Factory, advised me to start with three canoes and try and reach the right bank of Ship river, a distance of about thirty-two miles, and thus avoid the marshes that extend that far and then send back two canoes and walk the coast to Fort Severn, assuring me that the walking was good over sandy ridges.

Accordingly on June 26, a strong south wind having driven the ice out to sea, we started a micrometer survey from the mouth of the Hayes river eastward and on reaching the east bank of Ship river, sent back two canoes, keeping the largest one to forward supplies and outfit and ferry us across the mouths of the different streams, while with four men I continued the micrometer traverse walking along shore to Fort Severn, a total distance of 240 miles.

The salt marsh which lies between York Factory and Ship river extends inland from one to three miles beyond high water mark and almost reaches the tree line. From Ship river to Fort Severn there are also several salt marshes lying between high water mark and tree line, but none of them are of any great extent. At low tide the water recedes from half a mile to four miles, leaving only mud flats strewn with boulders.

Four good sized rivers enter the Bay between York and Severn,

1st	the	Broad river 78	miles from	York.
2nd	"	Kaskattamagan 95	"	"
3rd	"	Kettle river 126	"	"
4th	"	Goose river 196	"	"

The largest is the Kaskattamagan, which enters the Bay by three channels, forming two large islands at its mouth. We waded all these streams except the Kaskattamagan and never had water above our waists at low tide.

From Ship river, old wave-made beaches or sand ridges lie parallel to the water line most of the way eastward to Fort Severn, generally three in succession, but in some places there are as many as six between high water mark and tree line. Occasionally they are mixed with shells, driftwood and other debris and are from one to four chains in width and from half a mile to five miles in length. Near the tree line some of these ridges attain an elevation of about 30 feet above the present high water mark. Numerous fresh water ponds or lakes lie between these ridges. The largest seen was about three miles in length and ten chains in width and about ten feet deep along the centre line.

In the second ridge ten chains back from the present high water mark and fifteen feet above it, we found the remains of a ship partly buried in the sand. There was nothing to indicate how many years have elapsed since the ship was wrecked on this coast, but it must have been within comparatively recent years. Near Cape Tatnam the skeleton of a whale was found on the inner or south side of a range of dunes at an elevation of about fifteen feet above high water mark of to-day. Dunes having an elevation of fifty feet above present high water mark are seen at 163 miles from York Factory. These facts show that the land is rising somewhat rapidly along this coast.

One of the greatest difficulties met with in surveying this coast, is the floating ice which seldom clears away before the middle of July and is sometimes held there by prevailing northerly winds until the beginning of August.

When these ice floes, which are sometimes 20 to 40 feet in diameter, are driven ashore at high tide by the north wind, they become stranded and prevented us from reaching the shore; our canoe would thus have to remain imbedded in the mud until the next high tide or else we would have to portage all our baggage, which was seldom practicable.

From the 1st to the 12th July we were thus ice bound near Cape Tatnam and during all this time the thermometer on an average read about 45° Fahr. in day-time and at night it would descend below freezing point and the weather was generally foggy, another source of delay in micrometer work.

The country between York Factory and Fort Severn for about fifty miles inland is very low and flat. I took several walks through it while being detained by ice and fog and found it to be mostly muskeg.

We arrived at Fort Severn on the 3rd of August having made a continuous micrometer survey all the way from York Factory. Mr. Purvis, the officer in charge of the Hudson's Bay Company's post at Winisk arrived there the same day with a coast boat going to York. This gentleman and Mr. Laing, the officer in charge of the Severn, advised me to take this opportunity of returning to York, as the season was too far advanced to attempt continuing the survey farther eastward without running the risk of having to winter at Winisk. We therefore returned to York by this boat, arriving there on the 16th of August.

From a geological point of view there is nothing very interesting to be seen along that part of the Hudson Bay coast which we traversed. Nothing but mud flats and boulders looking seaward, and marshes, dunes, ponds and muskeg, bordered by stunted evergreen woods, chiefly small spruce, looking landward.

Speckled trout and white fish are plentiful at the mouths of all the rivers entering the bay. When at the mouth of the Kaskattamagan, we set the net at low tide and at the following low tide had over a hundred trout and white fish, over two pounds each. Caribou and red deer are also plentiful. Ptarmigan and duck are also numerous there. Foxes and wolves were seen all along the coast.

We spent a couple of days at York repairing our canoes and procuring supplies for our homeward trip by the Hayes river and Lake Winnipeg, and left on the 19th of August and arrived in Ottawa on the 18th of September.

My thanks are due to Mr. C. C. Chipman, Head Commissioner of the Hudson's Bay Co. and to the following gentlemen :—Mr. D. C. McTavish, Chief Factor of the Keewatin District, Mr. C. Sinclair of Norway House, Mr. Boucher of York Factory, and Messrs. Laing and Purvis of Fort Severn for the many kind services rendered me in carrying out the expedition.

The Headwaters of the Winisk and Attawapiskat Rivers.

Mr. William McInnes.

My instructions for the past summer's work called for an exploration in that part of the district of Keewatin, lying about the headwaters of the Attawapiskat and Winisk rivers, and between the Winisk and Trout lake, near the head of the Fawn branch of the Severn river. The route from Dinornic by the way of Lac Seal, Lake St. Joseph and the Albany river was chosen as affording the easiest way of taking in the necessary supplies.

This route had previously been travelled by several explorers and its geology was fairly well known. Some time was given, therefore, to supplementing the collection of fossils taken in 1903 and 1904. New species were obtained and many that had been collected before were found in other localities.

From Fort Hope, a H. B. C. post on Eabemet lake near the Albany river, the ordinary Indian route was followed to Lansdowne lake on the Attawapiskat river, whence a less frequented route was followed, leading from the northwest bay of the lake in a general northerly direction to the Winisk river, reaching it between Kanuchuan and Wapikopa lakes. This is not a very difficult route as, although it includes thirteen portages varying in length from a mile and a quarter to a few chains, there are long stretches of good water where canoe navigation is unimpeded. Leaving the bay above referred to by a portage of thirty chains, two small lakes, Obashin and Wagabkedri, emptying into the Attawapiskat river, are crossed and the stream is followed upwards through several small lakes to a divide, over which is a portage of a little over half a mile leading to a small lake at the head of one of the southern tributaries of the Winisk river. This small river is followed downwards, northeasterly, through two small lakes to the larger Mameigwess lake, eight miles long and deeply indented. It is shallow throughout, and with boulder-strewn bottom and many large and small islands. The surrounding forest of spruces, tamaracks and poplars is about eighty years old, the trees

averaging not more than ten inches in diameter at the stump. Joined to Mameigwess by a short narrows is a lake five miles long and quite narrow, from the north end of which the stream flows off to the Winisk river, whence the route cuts across through a number of small lakes to a stream entering one of the southern channels of the Winisk below Wapikopa lake.

Biotite-granite gneisses, with a few hornblende gneisses, varying in attitude from nearly flat to quite vertical, are the prevailing rocks, varied only, about seven miles north of Attawapiskat lake, by a three-mile belt of altered diorites and chloritic and hornblende schists. The Winisk river was then followed up for forty miles to Nibinamik lake, biotite gneisses being the only exposures seen, with the exception of a small area near the foot of Wapikopa lake, of pyroxene granite, with markedly porphyritic crystals of orthoclase, probably a much later intrusion. A few days were spent in tracing out more closely a body of intrusive hypersthene-gabbro, noted last year, which, examined in thin section by Dr. Barlow, proved to be practically identical with the nickel-bearing intrusive of Sudbury. These rocks were found to cover quite an extensive area just south of the Winisk river and their occurrence here is interesting from an economic point of view on the reasonable chance of their containing the nickel bearing minerals of the Sudbury area. In the cursory examination possible, however, no nickel or copper sulphides were found.

From Nibinamik lake upwards the course of the river lies in a general westerly direction with southerly bends here and there. It is characterized by long stretches of stiff current and rapids connecting wide-spreading lake expansions. Few exposures of rock protrude through the cover of drift ; those that are seen are biotite gneisses. Green forest extends all along the river with only rare and small areas of recent brule. The forest generally averages eighty years in age with considerable areas of about forty years growth. Much of the timber is from one foot to fifteen inches at the stump, spruces, tamaracks and poplars being the principal trees.

At the foot of Wunnummin lake, twenty five miles above Nibinamik, a micrometer survey was started for the purpose of more accurately defining this large lake, which is roughly represented on all the older maps, and to make a connexion between it and Trout lake at the head of Fawn river. The lake was found to be twenty-six miles long and in places five to eight miles wide with bays extending off at various angles. At the outlet, and northwards for two miles biotite gneisses only are seen, succeeded northerly by schists and diorites followed by heavy beds of conglomerate holding large boulders of a highly quartzose biotite granite. These rocks occur in a belt crossing the lake in a direction about N. 70° E. and closely resemble the northern part of the Minnitaki Keewatin area, as exposed at and near Abram lake. The main channel of the Winisk river was then followed as far as Misamikwash (Big-Beaver-house) lake, a distance of twenty-four miles. In general character it remains the same alternation of lake-like expansions with connecting stretches of swift water. The few rock exposures seen along this part of the river were biotite gneisses. The surface is largely drift covered, the river in many places showing cut banks of sand from ten to twenty feet high : it is rarely burnt, and the forest growth along and near the banks of the river is of good size.

Above Big Beaver-house lake the river divides into two main branches, the Pipestone, coming from the south and the Root river, from the west.

Ascending the northeasterly bay of Beaver-house lake to its head, it was found that the water was flowing out, and subsequent exploration showed that the outflowing stream was the headwaters of the west branch of the Winisk river, coming into that river again two hundred and thirty miles below at Asheweigkeiegen, one hundred and forty miles from the sea. An island is thus formed one hundred and thirty miles long and, where the two streams are farthest apart, seventy-five miles wide.

The route across to Trout lake from the Winisk is somewhat difficult on account of the small size and quick descent of the stream to be traversed. The outflowing stream from Beaver-house lake, the Asheweig, was followed, through several lake expansions and down long stretches of river with many rapids, for forty-seven miles to a small lake (Sturgeon lake of Dawson Brothers map of Manitoba, Keewatin, &c. 1880) into which a tributary comes from the west, carrying so little water as to be difficult of navigation by large canoes. This stream was followed upwards in a westerly direction for twelve miles, where a divide is crossed and another small stream, with many shallow rapids, leads to Trout lake. About half of the country traversed on this route has been burned within the past ten years and the remaining green forest portion shows trees of but small size.

Biotite gneisses are met with in occasional exposures, varied only by one small belt of hornblende schists, representing, doubtless, the tapering end of a Keewatin belt.

Biotite gneisses only are seen all about the southeast shores of Trout lake, well foliated and lying at low angles. The water of the lake is clear and cold and lake trout (*Salvelinus nemoycush*) were caught in good numbers by trolling.

Returning from Trout lake, in order to avoid the very shallow streams already traversed, a portage route was taken, leading by a number of long portages between small lakes lying in low swampy land, across to the inlet of Sturgeon lake.

From Sturgeon lake the Asheweig or West Winisk was followed downwards for thirty-three miles, the river for that distance being a succession of lake-like expansions. The connecting stretches are almost continuous rapids which may generally, however, be run, even by loaded canoes. The few portages made were in every case over level or slightly rolling sand and clay land with a deep covering of moss and a sparse growth of small spruces and tamaracks.

Leaving the Asheweig at a lake where its course turns abruptly northward, a portage of half a mile, over a low divide, led to a stream of considerable volume, flowing southwesterly, probably into Wunnummin lake. This stream, which proved to be, like the most of those already referred to in this district, an alternation of quiet water stretches, lake expansions and shallow, bouldery rapids, was followed upwards on a southeasterly course for twenty miles, to a small lake from which a series of small lakes and portages afford a route to a large brook coming from the west and flowing southerly into the Winisk river. The same recurrence of lake and rapid marks the course of this stream, the lakes being generally but a few miles in diameter though one, of irregular outline, has a length of ten miles.

The only rocks seen on this northern traverse were biotite gneisses, though, owing to absence of rock exposures along considerable portions, it cannot be asserted that the conglomerate and schist belt of Wunnummin lake does not extend, as would be expected, across the section explored. Gaining the Winisk river six miles above Nibinamik lake, the route passed over on the way in was again followed, with short digressions, to Fort Hope.

The timber over the whole area explored is for the most part of small size though, along the banks of the Winisk river and south of that river there are considerable areas of spruces, poplars and white birches reaching diameters, at the stump, of from one foot to fifteen inches. The country to the north of the Winisk, crossed on the way back from Trout lake supports, however, a forest growth chiefly of spruces and tamaracks that are seldom larger than eight to ten inches at the stump.

It will be seen from the foregoing description that by far the larger part of the area covered during the summer is occupied by Archæan gneisses. These rocks have, in a broad sense, a foliation trending about N. 70° E. but with abundant minor crumpling and large portions that lie nearly flat with a banded, stratiform character. The belts of Keewatin that are crossed at intervals when travelling north are much smaller in extent than the gneisses, to whose general trend they broadly conform. In general character and relationship to the gneisses they are quite similar to the belts of these rocks, so often described, in Northern Ontario. The whole district shows the effect of a general glaciation by an ice-sheet moving 20° to 30° west of south. The drift deposits are in many places comparatively heavy and to the direction of the Morainic ridges of gravel and boulders is due the frequent northeast, southwest trend of so many of the rivers and lakes. The highest hills seen were composed of unstratified gravel and boulders; a very remarkable one is situated twelve or fifteen miles to the south of Wunnummin lake. It is a perfectly isolated conical elevation rising, perhaps, three hundred feet above the general level. This hill was not seen at close range, but the Indians agree that it shows only gravel and boulders to the summit. Similar eminences were described in last year's summary report as occurring along the upper waters of the Attawapiskat, and Mr. C. Camsell, in the same report, refers to others a little farther west, just south of Trout lake.

The only inhabitants of the district explored are Ojibway and Swampy-Cree Indians who trade their catch of furs with the Hudson's Bay Company at Trout lake and Fort Hope posts. In summer, bands of these Indians, encamped on the shores of the larger lakes, subsist upon fish taken in their nets, which diet is varied only by an occasional grouse, duck or hare. Wild rice is not found in any of the lakes so that they lack the autumn substitute for flour of the more southerly tribes, and berries are not plentiful enough to form any considerable part of their cuisine. A few have built log huts at their winter quarters with fireplaces and chimneys built of wicker and mud, but the majority still content themselves with the teepee built of poles and covered with birch bark or, in the case of the more northern families, with moss, cut out in blocks just as the Eskimos cut snow. During the winter they are engaged in hunting and live mainly upon hares and fish; in the spring, camped close to a rapid on one of the larger streams, they live on fish, principally carp, caught automatically by a michiken or fish-weir, crossing the stream at the rapid.

The tracks of a few moose were seen between the Attawapiskat and Winisk rivers, but this is practically their northern limit in this longitude as, in the country to the north of the Winisk, the bushes on which they commonly browse are scarce or altogether wanting. The fur-bearing animals generally found in this latitude are all fairly abundant, with the exception of beavers, whose food trees are generally scarce over the muskeg areas.

Sturgeon are abundant in many of the lakes and rivers, and whitefish, lake-trout, doré and pike are found wherever the conditions are favourable.

From Fort Hope the route out by the Albany river and Lac Seul was taken, and it was found that transportation companies, in anticipation of the freight and passenger traffic arising out of the construction of the Grand Trunk Pacific railroad, had already two small steamers, on Sandy lake and one larger one on the route across Minitaki lake and down the English river. In low water this steamboat could only reach the outlet of Minitaki, but a dam, that would raise the water two feet, would probably suffice to flood out both the small rapid at the foot of Pelican lake and that at the foot of Abram lake, making a channel, deep enough for small steamers, as far as Pelican fall, a distance of thirty-nine miles from the end of the team road at Sandy lake. Ottawa was reached early in October.

The Lake Superior Region between the Pic and Nipigon Rivers.

Mr. W. H. Collins.

I spent the past field season in making exploratory surveys and a geological reconnaissance of a portion of the Archæan region north of Lake Superior. I was assisted in the work by Mr. H. C. Cooke. The area explored is rudely triangular, being enclosed by the shore of Lake Superior from Heron Bay to Mazokama, the Pic river and the Height-of-Land. It extends 80 miles along Lake Superior and northward 50 miles. Throughout, it is a peneplain of rounded hills of crystalline rocks 300 to 400 feet high, terminating abruptly along the south. Soils are scantily distributed, the old rocks being exposed, except in the depressions and river valleys.

Surveys.—Surveys of the principal streams and canoe routes, including the Little Pic, Steel, Black, Pays Plat and Gravel rivers, were made with the aid of a micrometer telescope and compass, the whole distance measured being 337 miles. Where the country was accessible only in light canoes or by overland travel, traverses were substituted and about seventy miles were covered in this manner.

Drainage.—From the Pic river to the basin of Lake Nipigon, the distance between the Height-of-Land and the shore of Lake Superior decreases from fifty to twenty miles, although the altitude of the former, which is about 450 feet above that of the lake, varies but slightly. Consequently, all the rivers on this slope are small and swift, becoming progressively more so from east to west. All rise among the multitude of small lakes that lie scattered over the level country forming the Height-of-Land and, in their upper portions, are sluggish, spilling from one natural depression to another until the region of

lacustrine deposits is reached. These deposits, whose levels are approximately 250 feet above the present lake level, extend on the Steel river a distance of twenty-three miles inland and have been readily cut down by river action to form evenly graded and monotonous beds. Through such formations the streams are shallow, rapid and meandering. Just before entering Lake Superior, both Black and Steel rivers descend in rapids and falls a distance of nearly 200 feet, affording excellent water-power within easy reach of the railway.

Geology.—Geologically, the country was found to consist almost entirely of Archæan granites, gneisses and schists, penetrated by igneous granites, syenites, diabases and diorites of later age. A band of green schists, bearing lithological resemblance to the Keewatin rocks, follows the coast westward nearly to Rossport. North of this lies a complex of gneiss, characterized by a friable biotite schist and penetrated by dikes and small areas of very coarse acid granite and a few large diabase dikes. An interesting area of nepheline and augite syenites extends from Peninsula to Middleton on the C.P. railway and northward about four miles. Farther west, from Jackfish to the neighbourhood of Gurney, is a larger area of granite varying to syenite. At the western end of the triangle, red, calcareous shales of considerable thickness lie horizontally and unconformably upon the Archæan, and are in turn covered by a thick cap of diabase.

The terraces of post-glacial clays and sands already mentioned partially fill most of the river valleys, affording some patches of agricultural land. These are finely bedded and fossiliferous in places. The northern portion is partly covered by glacial debris and the exposed rocks show glacial phenomena abundantly. Morainic ridges were observed south of Kagianogama lake.

Minerals.—Economic minerals occur in considerable variety but rarely in paying quantities. A black, ferriferous sphalerite occurring as irregular bodies in diorite, has been obtained at the Zenith mine near Rossport, but mining operations are temporarily suspended. This area of diorite, which is about three miles across, contains blende of similar character at other points. Gold has been mined with moderate success on the Ursa Major and Empress properties, near Jackfish. Limonite was observed filling some small veins in granite a few miles west of Rossport, and magnetite occurs in a biotite schist on Caribou lake just north of the Zenith mine. Magnetite also occurs as thin layers in black schist near Schreiber and as magnetic sands at points distributed over the whole area. The magnetite-bearing segregations near Middleton are probably valueless, owing to the high percentage of titanium. Pyrite and pyrrhotite occur at various points in the hornblende and green schists near Lake Superior.

Forests.—The forests have been destroyed over a large portion of the area explored, especially in the vicinity of the railway, and are now replaced by second growths of poplar. The old forest contains cedar, spruce, tamarack, poplar and both white and yellow birch, the latter being abundant, although quite rare a short distance farther north. Growth is comparatively rapid and trunks of yellow birch twenty inches in diameter were observed. Along the Pic, Pays Plat and Gravel rivers a considerable quantity of timber has been removed in the past, as evidenced by wood roads and choppings.

I wish to convey my thanks to Mr. H. C. Cooke, of Toronto, for assistance given in the field, and to Mr. Joseph Miller, of Heron bay and to many gentlemen of Rossport, Jackfish and Middleton for various kindnesses.

W. H. COLLINS.

THE REGION BETWEEN LAKE TEMAGAMI AND SPANISH RIVER.

Mr. W. J. Wilson.

I received instructions from you to prepare a geological map of sheet No. 139 of the Ontario series, and to write a report on the same. This sheet lies adjacent to and west of the Lake Timiskaming sheet and north of the Sudbury sheet. It is seventy-two miles long and forty-eight miles wide, containing 3,456 square miles. As very little topographical work has been done in this large area it is necessary to make a survey of the lakes and rivers examined in order to fix the geological boundaries. The area contained in this sheet is covered with a dense forest and abounds in lakes and streams, most of which are difficult of access, so that the progress of the work is comparatively slow. It will, therefore, take at least two more summers to finish the surveys, and as a full report will be written to accompany the completed map, only an outline of the work done during the summer will be given in this report.

I left Ottawa June 1st, and reached Temagami the same day. While there I studied the iron range on the northeast arm of Temagami lake, and spent a day at Cobalt noting the rocks and ores of that locality. On June 6th I arrived at the Hudson's Bay Company's post on Bear island, Temagami lake, where I procured my supplies for the summer's work, and the next day started for Lady Evelyn lake accompanied by Mr. George L. Cameron, of Mount Albert, Ontario, as assistant, and three canoemen. The survey was commenced at a small island in the northwest part of Lady Evelyn lake, and continued west through Willow Island lake, and up Lady Evelyn river to its source in Apex, or Kettle Stone lake, whence it was carried north into Smoothwater or White Beaver lake, and down the Montreal river to the first portage, a distance of six miles from the lake. Returning to Apex lake, the canoe route southwest to the Sturgeon river, at the mouth of Stull branch, was surveyed, passing through ten small lakes and over ten portages. Dr. Bell surveyed this route in 1876. From this point the survey was continued down the Sturgeon to the mouth of the Obabika river.

Having procured fresh supplies, the Sturgeon river was ascended for five miles above the mouth of the Obabika, from which point I turned north on a canoe route to Lady Evelyn river. This route runs roughly parallel to that already surveyed from Apex lake southward. It is rarely used, and proved to be very difficult. The portage from the Sturgeon is more than three miles long and had to be cut out the greater part of the way. At the north end it connects with a series of lakes and portages, many of which have not appeared on any published map. The largest of these lakes, Florence, is six miles long and empties into Lake Evelyn river by a sluggish stream a mile and a half long, at the mouth of which the survey was tied to that of Lady Evelyn river.

I again went to the Hudson's Bay Company's post for supplies, but found great difficulty in getting a guide, the large number of tourists having engaged all the available men. It was, therefore, necessary to obtain a smaller canoe and continue the work with my assistant and only two canoemen. I went west through Obabika lake and surveyed the route from the outlet of Round lake, down the Obabika river to the Sturgeon, connecting with my former survey of this river. I carried the survey down the Sturgeon to the south boundary of the sheet, and came back ascending the river to a point about four miles above the mouth of the Obabika, where a portage leads southwest to a small lake. This is the beginning of a canoe route to Wanapitei lake, which I followed as far as Chinigoochichi lake. Having surveyed the northern part of this lake I went northeast to the Sturgeon river through six lakes, three of which are of considerable size. The last portage on this route joins the Sturgeon river about eighteen miles above the mouth of the Obabika. The Indians frequently use this circuitous route to avoid the rapids and shoals of the Sturgeon.

At the end of this trip, Mr. Cameron having returned home, I left the Hudson's Bay Company's post with three canoemen and followed the usual canoe route to Wanapitei lake via Gull lake, the Sturgeon river and Maskinonge lake. The survey of the upper Wanapitei river was begun at its mouth in Wanapitei lake and continued up to the crossing of Niven's meridian line, 1896, and five miles farther west. Welcome lake, which is crossed by Niven's line five miles south of the Wanapitei river, was also surveyed.

The valleys of Lady Evelyn, Sturgeon and Wanapitei rivers are fairly deep but in most places narrow, having hills rising to a height of 200 feet or more a short distance back. There are two falls on Lady Evelyn river the highest being about ninety feet. This is over a bare quartzite cliff and would make a good water power. There are also numerous rapids and shoals which impede navigation and make travel impossible for loaded canoes in low water. The Sturgeon river is rapid and rough in its upper part and has many falls that could be utilized for water powers. The best of these is Kettle fall which is over forty feet high. The upper Wanapitei river from its mouth to near the northern boundary of the township of Aylmer is deep and of moderate current; above this, for twenty miles, it is almost one continuous rapid and is so shallow that we sometimes had to drag the canoes. Above the stream from Welcome lake the river is deep and winding and flows through a level sandy-clay soil.

The geology of the area examined is too complex to admit of a detailed description until after the collected specimens have been thoroughly examined. In general, the rocks resemble closely those lying to the east in the western part of the Lake Timiskaming sheet. They consist of Laurentian, Keewatin and Huronian with large intrusive masses of new greenstone. White, reddish and greenish quartzites are found occupying large areas on all the routes examined and form many of the rounded hills, which abound over the whole country, while hills composed of the new greenstone frequently have one side an almost perpendicular cliff rising 100 or 200 feet high. Syenite and gneiss were noted on the Sturgeon river at Paul, or Ghoul, lake and Twin falls, and on the Wanapitei river for some miles above and below the mouth of the stream from Burwash lake. 'Breccia Conglomerate' occurs in several places between the Sturgeon

and Lady Evelyn rivers and north of Chinigoochichi lake. A band of calcareous slate was seen on Welcome lake.

The greater part of the country is covered with an old forest growth and no heavy fires have over-run any part of it within the past fifty years. White, red and Banksian pine and spruce are plentiful and grow to a large size. Some of the white pine measure ten feet in circumference five feet from the ground. Poplar, canoe-birch and cedar are also common.

Good speckled trout abound in Lady Evelyn river, and lake trout, pike, pickerel, bass and whitefish are common in nearly all the rivers and lakes.

Moose are very abundant. As many as fifty were seen during the summer and their trails were noted along the rivers and lakes. Only a few red deer were observed. Wolves were frequently heard in the valley of the Sturgeon river.

The red and white pine over a large area show the effects of some blighting influence; from one quarter to one half of the foliage of many trees has been killed and turned reddish or grayish-brown. Probably this is caused either by the larvæ of some insect similar to the larch sawfly, which has killed all the tamarack in the district or to a fungus blight. Whatever the cause, it will, if continued for a few years, result in the destruction of a vast amount of valuable timber.

I am indebted to Mr. H. G. Woods of the Hudson's Bay Company for much valuable assistance in the prosecution of the work.

The Muskoka District.

Dr. T. L. Walker.

In accordance with instructions received from the Director of the Geological Survey of Canada, I left Toronto on the 21st of June, 1905, for Penetanguishene with a view to continuing the geological survey of the Muskoka sheet. The field-season continued from that date until the 28th of September.

The Muskoka sheet comprises parts of the districts of Muskoka and Parry Sound, extending from the Georgian Bay shore eastward to the Haliburton sheet, a distance of more than seventy miles from east to west. It was hoped at the beginning of the field season of 1905 that I should be able to supplement the observations already made in this district by A. Murray, Dr. Bell and other geologists, so as to make it possible to prepare the report and map of the sheet for publication. Every effort was put forth during the short field-season, but I fear that as yet we possess only an outline on which considerable detailed work should be expended.

Throughout the whole of the field season I had the assistance of Mr. R. E. Hore, B.A., of Toronto. Later the party was increased by the arrival of Mr. W. D. Herridge, of Ottawa, and Mr. J. D. Wood, of Toronto, the latter gentleman as a volunteer worker. While planning at Penetanguishene for the coast trip in the sail-boat, I secured the

services of Jean Bissette, who was the only white man with Alexander Murray's party while exploring the Muskosh in 1853. To all of these assistants I am indebted for zeal and enthusiasm in the prosecution of the work.

The first three weeks of the season were spent in examining the shore and islands of Georgian bay. This work was carried on while travelling in a sail-boat. In this way we were able to carry on the work in a manner which would have been impossible for us had we been limited to canoes as a means of transportation. The shore journey was undertaken at the beginning of the season so as to give an opportunity of observing the splendid rock exposures along both the mainland and the islands, in this way obtaining the benefit of a satisfactory classification of the chief rock types. From the 15th of July to the 6th of September we travelled by canoes, starting from Port Severn; after examining the shore line in detail as far as Franklin island, we proceeded inland to the Muskoka lakes and finally southward to Sparrow lake and the Severn river. During this tour many lakes and rivers were traversed, but, owing to our desire to secure an outline of the whole of the Muskoka sheet, many of the water courses have yet to be examined before the completion of the work. The last three weeks were devoted to overland exploration, travelling most of the time by road, using a team and wagon for the transportation of our impedimenta.

The forest growth varies from spruce and tamarack on the flat wet land, white and red pine, birch and hemlock on dry sandy soil, to beech, maple, birch and hemlock on dry land, containing considerable clay and covered with a dark humus. Unfortunately for the Province of Ontario the more valuable timber, pine particularly, has been harvested by the lumberman, cleared away by settlers or destroyed wholesale by fires, many of which might have been prevented had we earlier learned the value of our splendid forest land.

The whole of the region examined has been covered by an ice sheet and glaciated. The general movement, as indicated by the striæ, was from N. 15 E. to N. 25 E. Frequently the smooth and rounded rock surface is quite free from covering, though, as a rule, the glacial drift forms a mantle of considerable thickness.

Apart from recent formations the rocks of the district are as follows :—

1. Palæozoic-Trenton.
2. Gabbro intrusions.
3. Anorthosite intrusions.
4. Granitoid Gneiss.
5. Grenville Series.

These rocks are mostly limestone, occurring along the southwestern margin of the sheet, comprising Christian, Hope, Beckwith and Quarry islands as well as some portions of the mainland from the town of Midland westward. These rocks are quite undisturbed and rest unconformably on the eroded surfaces of the banded rocks of group 4. They have not been examined in detail, nor have the fossils collected from them been determined.

Two important areas of these rocks have been discovered and mapped. One of them comprises the little peninsula at Moores Point in the township of Baxter, the

second the northeastern part of Parry island. In both of these there is evidence that they are intrusive and of an age more recent than either groups 4 or 5. Considerable variety in petrological composition and structure has been observed. "Mines" of copper are reported to be associated with both of these massifs.

Plagioclase rocks (Anorthosites) occur along the western sides of Parry island; on the shore of the long narrow Twelve Mile bay in Freeman township; on the Severn river, a short distance east of Port Severn, and in other places. Normally the anorthosite is a white rock with small quantities of the dark mineral arranged in such a way as to give rise to a faint banded structure. Its associates are usually gneisses of the Grenville series, so that the impression is made that this rock is an early igneous constituent of the gneiss complex, consisting of schists derived by the metamorphism of sediments.

A very common rock in many parts of the Muskoka district is a more or less banded pinkish granite or granitoid gneiss. It may become almost as massive as a granite but this massive portion is usually surrounded by better banded types. Such typical massive centres were observed—(1) On the islands and shores of the northern part of Lake Joseph. (2) On the islands and shores of the northern half of Parry sound. (3) On Beausoleil and adjacent islands, and (4) on the islands to the north of the entrance to Go-Home bay. The commonest type of rock is composed almost entirely of pink feldspar, (microcline or orthoclase), glassy quartz, with smaller proportions of garnet, hornblende and biotite. The dark minerals are arranged in bands, usually making the rock assume the banded structure of gneiss. In mineralogical composition these rocks are orthoschists metamorphosed or pressed igneous types. They usually dip under the rocks of the Grenville series which are probably the oldest of the rocks referred to in this report.

These rocks make up the major part of the Muskoka sheet. They are composed of crystalline limestones, graphitic schists, sometimes with sillimanite and rose-tinted garnet, granular grey gneiss and dark hornblendic rock usually schistose but sometimes massive. The Grenville series appears to present a metamorphosed complex of rock-sediments of varying chemical composition with igneous intrusions, dikes, or flows, which were associated with them prior to the metamorphism. The rocks of this series are frequently cut by pegmatite dikes, the only variety of dike met with in the region. This freedom from intrusive dikes seems to indicate that since the metamorphism of the Grenville series the region has experienced a very long period free from great earth movements.

The chief interest, so far as economic minerals are concerned, centres in the region within a radius of ten miles of Parry sound. Inside this area, copper and gold prospects are frequently associated with the rocks of the Grenville series. The best representative of this class of deposit is the Gowan mine near Parry sound. Farther east, mica has been discovered in various parts of the township of Christie, but as yet no actual mining is being carried on.

Niagara Falls and Niagara District.

Dr. J. W. Spencer.

Many years ago I had the opportunity of making a long detailed study of a portion of the Niagara peninsula, which was published under the title of 'Geology of the Region about the Western End of Lake Ontario.' These investigations led to the study of the physics of Niagara river, showing that it was modern and not preglacial.

Another investigation, though not immediately in the Niagara peninsula, was of the greatest importance in its bearing upon Niagara Falls. In 1888 I traced, from the foot of Lake Huron, the Algonquin beach, which I so named, around Balsam lake, and found that this beach rose from near the lake level at the present outlet of Lake Huron to a considerable height at Balsam lake, where it was breached by a former outlet into the Trent valley. This discovery more than any other has affected the determination of the recession of Niagara Falls, for it showed that, until lately, Niagara Falls received only the drainage of the Erie basin. I also found a lower terrace much below the outlet of Lake Huron, which Mr. F. B. Taylor connected with Lake Nipissing, where there was a later and lower outlet.

Later, in 1894, I published the relationship of the Iroquois beach at the mouth of the Niagara gorge to the Falls, and showed that the river descended a much less height then than at the present time. I also found a fragment of the floor of the river of that time at Foster's Flats, showing that the Falls receded over three miles, while the descent of the river was low and the volume of water much less than now. These and other features enabled me to make an entirely new departure in calculating the age of the Falls based upon the changing physics of the river, which, from the data then available, placed them at 32,000 years. But the physical structure in the region of the Whirlpool, for more than two miles in length, practically defied investigation.

A new interest had arisen in the Falls, from the utilization of the water for power purposes on the one hand, and the preservation of the scenery of Niagara on the other. One good representation of the position of the Falls in 1819 is preserved, but it is not sufficiently accurate for exact comparison in determining the recession. In 1842 Prof. James Hall laid the foundation of correct investigation by making a trigonometrical survey. Again, in 1875, 1886 and 1890 surveys were made: all of them by officials of the State of New York or of the United States, and none by Canada. In October, 1904, I commenced a survey, with the assistance of engineers from the Electrical Development Company, of the Canadian Falls, the recession of the American Falls being immaterial on account of its slowness. This was the first Canadian survey, and the fifth in all that had been undertaken. In June last, I began the revision of the entire work of the changing physics of the river. The new features which developed occupied very much more time than any one could have anticipated, but with almost daily discoveries. I have spent about five months in the field, engaged in this work.

In my earlier writings on Niagara Falls, the discharge of the river was based upon the old determinations of the United States engineers. These, however, are now superseded by very much more accurate ones that have lately been made. The various power companies also afforded opportunities of detailed investigation which would not have been obtainable at a later date on account of the departure of the engineers who had made the measurements.

In June, the weather and the direction of the wind were unfavourable for the re-survey of the crest of the Falls, but this was accomplished in August, and revised in October. In the latter part of November, an important rock-fall occurred which will be shown, approximately, on the map. The result of this re-survey of the Falls shows that during the years from 1890 to 1905 the recession has been only about one-half of that of the previous fifteen years. Only a small portion of this reduction can be attributed to the use of the water on the American side. Part of it is unquestionably due to the shape of the crest producing a greater resistance, for it has been found that the rate of recession is far from uniform, except over averages of long periods. But, by the study of the level of Lake Erie, records of which have been kept, and of the discharge corresponding to the changing levels, it has been found that this has been greatly reduced during these later years. This has been one of the causes of the lessening of the rate of recession of the Falls.

The recession of the Falls shows that it is not merely a question of the undermining of the hard, overhanging limestones by the removal of the shale beneath, but that the limestones are breached along joints which are opened and are finally wedged off, thus allowing the waters to strike upon lower ledges, as is shown in the rock-fall of November, 1905, producing one of the finest effects of the cataract. A feature of the recession is the alternating of a broad or flat crescent with one having a wedge-shaped apex. Since 1890, about one acre of the rock at the brink of the Falls has been removed.

The width of the river between Goat island and a fragment of the old shore line at Table Rock is about 1,200 feet. For purposes of computation this may be taken as the breadth of the gorge. If we take the average for the recession or lengthening of the gorge, then we find that during the last fifteen years it amounts to 2·2 feet per annum. Between 1890 and 1875 the annual average was 5·4 feet; between 1875 and 1842 it was 4·5 feet per annum; and between 1842 and 1819 it was apparently much more. This represents an average since 1842 of 4·2 feet per annum. Since 1842 the centre of the Falls has receded 285 feet, all of which was effected before 1886, since which time the processes of recession have been expended in widening the crescent.

Less than one-tenth of the total discharge of Niagara passes over the American Falls; the remainder coming down through the Canadian channel between Goat island and Queen Victoria park. At the first cascade near the head of Goat island, the ledge of rock, apparently uniform in depth, extends nearly to the Canadian shore and determines the height or level of the river, which is ten times as wide as the channel on the eastern side of Goat island. On account of this ridge, the power companies that take their water below it will produce little or no effect in disturbing the level of the river above; or, in other words, lowering the water on the New York side. But one of the

power companies takes its water at the end of this ridge and has a franchise for more than double that of the other companies. This water when used must draw off a large volume of water from the New York side, and will also affect the whole discharge from the Canadian Falls, as indeed will also the other power companies. From the determinations of the engineers, it is found that the discharge of Niagara Falls is reduced by about 23,200 cubic feet per second when Lake Erie at Buffalo is lowered one foot. During the latter part of June, the water was high and the discharge over Goat island shelf made a continuous sheet of water; in August it was a few inches lower, and over portions of the shelf, the sheet was reduced to simply strings of water. This will give some idea, in advance, of the effect of the diversion of the water from the river to the various tunnels. The reduction of ten or fifteen per cent in the discharge in the river will narrow the channel and divert the water from its shallower portions. To modify the effect, the Canadian side of the Falls has been reduced by several hundred feet.

In the course of the survey, I observed what had generally escaped the attention of previous surveyors. The International Boundary is not a changeable feature, but was established by the International Commissioners in 1819. The boundary line has never been shown correctly on any map, that I have seen, except that published by the U. S. Lighthouse Board. This line is distant from Goat island about 300 feet, so that it places all but one horn of the crescent of the Canadian Falls in Canadian territory, as is also the river for some distance above the cataract. This leaves the preservation of the falls largely under the jurisdiction of Canada. That this line is not far from the deep part of the channel is established by soundings (192 feet), the centre of the river below the falls being very much more shallow (84 feet) than the deep channel close under Goat island shelf. This feature was not discovered until I made the first soundings ever undertaken.

Another feature of the investigation was one very difficult of execution. This was the soundings of the river in the gorge at various points. A number of soundings had been made by the United States Lake Survey in the vicinity of the Upper Steel Arch Bridge, or at the crossing of the 'Maid of the Mist', but none had been taken in front of the American Falls, or above it to the crescent. I carried my soundings much farther than the line to which the 'Maid of the Mist' usually runs, and also nearly as far down as it is safe to navigate the river above Whirlpool rapids. Again, a line of soundings across the Whirlpool was obtained which required a movable cable to be carried across the gorge from which the sounding apparatus was operated. As the Whirlpool contains so many logs, which caught the wire when it touched the water, the difficulties were very great; but the soundings were eventually successful. The over-currents of the river here are not extraordinary, but I found the most remarkable under-currents, so that nearly all the water describes a spiral form and passes out as under-currents. Farther soundings were made across the river just below the outlet of the Whirlpool. Here the cable broke three times; once with peril to the men in the boat. All the depths were obtained by the Tanner-Blish sounding tubes, which record the weight of the superincumbent water and are unaffected by the velocity of the river. This was the only practicable method of ascertaining the depths.

From the soundings in the gorge it is found that the depth of the river varies greatly and shows many remarkable features. But it would be premature to announce

these results until the significance of the whole can be presented. Thus, in the centre of the cauldron beneath the Falls, and as near the Falls as a boat dare go, the depth was found to be 84 feet; while close under Goat island shelf it reaches the extraordinary depth of 192 feet. This feature by itself becomes only a curiosity, and is inexplicable unless the subject is treated as a whole. However, I may elsewhere somewhat enlarge upon this subject.

Professor Hall's survey in 1842 shows the crest of the Falls to be an unbroken crescent; the U. S. Lake survey soundings in 1875 would suggest that the middle of the river was deepest; Prof. Woodward's measurements in 1886, showing the apex at one side of the crescent, would be suggestive had not the two previous surveys shown the outline of the Falls to be nearly regular. Therefore it was a surprise to find this extraordinary depth close upon one side of the cauldron. Turning back to the form of the Canadian Falls in 1819, we find a very deep V-shaped incision in the crest line located near Goat island shelf, showing that there the deepest channel was to be found. This feature was subsequently shown in repetition from 1886 to 1890. Accordingly this deep sounding occurs in the line where the changing apex of the Falls has reappeared. As yet, however, it would be bold to assert that even near the present apex the channel is being excavated to this phenomenal depth.

It is generally known that at the end of the Whirlpool a buried channel occurred, which, to a great extent, gave rise to the Whirlpool. As the ground is levelled over in this region by drift, it could only be studied at the two ends—at the Whirlpool and in St. David's valley, where drift of greater depth occurs. In the apparent valley above St. David's I found rock at 250 feet above Lake Ontario, reducing the possibility of a buried channel to a breadth of not over one-third of a mile; also at some points where streams cross its edge the channel is exposed, showing it much farther east than had been supposed. Here the face of the rocks of the channel are highly glaciated, thus indicating its age. By well borings the western border was further established. At 1,140 feet east of the western wall I sunk a well and found it was within the channel. At another point about 630 feet from the western well I have sunk another well to a depth of about 230 feet, or to a point about 75 feet above the level of the whirlpool, without reaching rock. This is to a point below the gas bearing rocks. This work will be resumed to try to reach the bottom of the channel.

The air currents in the well, which were a remarkable feature, suggest that it is in proximity to crevices that would seem improbable outside of cavernous rock. Wherever the drift of this region is removed, a highly polished rock-surface is revealed, with the direction of glacial striae oblique both to the face of the Niagara escarpment and that of the gorge. While red, and sometimes blue, clay is found at the surface, the filling of the channel is made up largely of sands and more or less angular gravels which render boring very difficult, and no water wells can be obtained in the channel. At 186 feet below the surface, in the buried Whirlpool gorge, I found white spruce wood in a fair state of preservation. The drift here is a subject which has not been systematically studied by any one, and many new features have been added in this survey. On account of the character of the drift, there has been much uncertainty as to the correct boundary line of the Niagara limestone formation on the one hand, and

the Corniferous limestones near Lake Erie on the other, with the intermediate Salina formation in the fundamental rock-surface below the drift.

From the study of the beaches, I first pointed out many years ago, the probable future extinction of Niagara Falls by the diversion of the waters into the Mississippi, and computed the time when the water of the river would be drained as far back as Buffalo, at several thousand years. The rate of the rise of the land is now challenged by the new observations, and even if these were correct, new features hitherto unobserved would so modify the results that probably much more than 5,000 years must elapse before Niagara will be diverted into the Mississippi.

My full report upon the subjects herein indicated must be lengthy, and as there has not been sufficient time to systematize the results, I must postpone publishing at this moment the undigested facts. Several discoveries of the greatest importance have been made, and much new light on the mode of recession of the Falls and their capabilities has been found.

As the natural gas of the Niagara peninsula comes principally from the Clinton and certain of the Medina beds which are dissected by the Niagara gorge, I have also given this subject consideration. These rock beds, while they come to the surface at the brow of the mountain, dip to the southward; the precise direction will be given when the computations are made. They are at a considerable depth below the surface where the wells are most productive.

Including all my previous work in the region of the Great Lakes, the forthcoming report on the Niagara district is expected to be the most important. My former estimate of the age of Niagara must be increased. I have also, for the first time, satisfied myself to what point Niagara Falls had receded when Lake Huron first turned its waters into Lake Erie.

Certain terraces about the lakes have a most important bearing in explaining the physical changes of the Falls. All the work above indicated has been done instrumentally, so as to arrive at the most satisfactory results. The borings are still in progress and more additional revisions in the field will be necessary. But the final report is being prepared with the utmost rapidity and contains the results omitted here for the reasons above given. When published, these discoveries will greatly add to the knowledge of the geology of Niagara district and of the Falls.

It may be added that the water that passed over the Falls during its highest stage in May, 1905, reached 267,000 cubic feet per second; during its lowest stage in February the discharge fell to 164,000 cubic feet per second. These figures would correspond to 4,900,000 gross horse power for the larger figure, and 3,021,000 gross horse power for February. But the total work done by the river between the two lakes will double this amount.

THE PETERBOROUGH SHEET.

Mr. W. A. Johnston.

My instructions were to complete the geological survey of the Peterborough sheet. A considerable part of this sheet had already been surveyed. The remaing part included the townships of Murray, Seymour, Percy and Alnwick in Northumberland county; Dummer, Asphodel, Otonabee, Monaghan, Douro, Smith, Ennismore, Harvey and Galway in Peterboro' county; the northern part of Manvers and Cavan in Durham county and Emily, Ops, Fenelon, Verulam, Somerville, and the southern part of Lutterworth in Victoria county. Nearly all the roads in these townships were surveyed by means of a compass and a bicycle with cyclometer attached, and the different rock formations were mapped out as well as the overlying drift would permit.

Owing to the absence of roads, the central portion of the township of Galway was difficult of access. The main outlines of the different crystalline rocks, however, were fixed by making traverses across it. I proceeded to Campbellford on the 2nd of May and began work at the Hastings line, east of which the country had already been surveyed. The month of May was spent in Northumberland county. On June the 6th my assistant Benj. Tett, B. Sc., joined me. During the greater part of the summer we worked separately, and in this way a considerable area was covered in a comparatively short time. Mr. Tett's work was confined to the southwestern corner of the sheet, our work being connected up at several points. We returned to Ottawa on October 2nd.

Geological Description—Nearly the whole of Northumberland county is covered with drift which appears to be everywhere underlain by Trenton limestone with the exception of the northeast corner where the Black River formation comes in, resting on Laurentian gneiss. The Trenton limestone—usually in thin beds and containing an abundance of well-preserved fossils—forms the bed and banks of the Trent river, from Trenton to Healy falls, five miles above Campbellford. This formation was also seen in various places in the beds of creeks as far west as the village of Warkworth. From the upper end of Crow bay, a few miles above Campbellford, along the Crow river to the Hastings line, the Black River limestone rocks are exposed, resting on the Laurentian gneiss which appears at Allans Mills and at the Crow rapids. Westward from Northumberland county, roughly speaking, a line drawn from the village of Hastings through Lakefield and Fenelon falls to Balsam lake would define the boundaries of the Trenton on the southwest and the Black River on the northeast.

The dividing line between these Cambro-Silurian limestones and the Archaean rocks is very irregular and several outliers of Black River limestone occur to the north of the Trent valley chain of lakes in Harvey township, Peterboro' county. In this county, the contact with the Laurentian gneiss and amphibolite occurs along the south side of Stony lake and Deer lake, as far as Buckhorn, where it strikes northwest across Sandy lake to the north shore of Pidgeon lake. The islands of Stony lake are composed of Laurentian gneiss, banded with amphibolite.

In Victoria county the Black River limestone extends as far north as the village of Norland and east from there to Silver lake on the town line between Victoria and Peterboro' counties.

The northwesterly corner of the sheet is occupied principally by the limestones of the Grenville and Hastings series, with several comparatively large areas of the Fundamental gneiss. One of these areas occurs in the southeasterly portion of Galway township and another in the southeasterly part of Lutterworth and in the vicinity of Kinmount. In the central and westerly portion of Galway township a large area of crystalline limestone, interstratified with bands of gneiss, amphibolite and quartzite is developed. The general strike of these limestones is S. 30° W. with a dip of 30° towards the S. E. They frequently contain bands of bluish-black, partially altered, limestones, and limestone-conglomerates occur about the centre of the west line of Galway. In Lutterworth the gneiss predominates with several comparatively small areas of pure white crystalline limestone, which is more especially abundant around the southern end of Gull lake. About five miles south of Kinmount, a trap dike, striking north and south, cuts the crystalline limestones and interbanded gneiss, and, in several other places in Galway, small outcroppings of volcanic rocks were seen. The limestone is also invaded by numerous granite and pegmatite dikes.

DRIFT.

Nearly the whole of the country south of the Trent valley chain of lakes is covered with drift material. The northern part of Durham county is especially hilly. Nearly all the hills and ridges which have a general trend towards the southwest were found to be composed of boulder clay with a superficial covering of sand and gravel. Only occasionally are good gravel pits found like that near Fenelon Falls.

LITHOGRAPHIC STONE QUARRY.

The only quarry examined was the one situated slightly to the north of Burleigh Falls. From here a first-class lithographic building stone was being shipped to Burnt River station, on the Lindsay and Haliburton railway.

MINERALS.

Most of the mineral occurrences of this sheet have been already described. None of the mines were in operation.

CORUNDUM.

A still further occurrence of corundum in the corundum belt of Ontario was discovered by my assistant, Mr. Tett, on lot 12, concession iv, of the township of Lutterworth, in Victoria county. The corundum bearing rock here is a pink syenite, cutting the gneissic granite of the district, and occupies an irregularly shaped area of thirty or forty acres, throughout a considerable part of which corundum was found in more or less abundance. A small hill, over which the road from Kinmount to Norland passes, is especially rich in the mineral, and a considerable part of it would probably go 10% corundum. Associated with the corundum is a small amount of pearly mica or altered

corundum and magnetite. This occurrence of corundum may prove valuable ; it is easily accessible, being only about five miles from Kinmount on the Lindsay and Haliburton railway.

COAL.

One of the places where coal was reported to have been discovered was visited, viz. : lot 4, concession 4 of Ennismore, Peterboro' county. A few pieces of coal had apparently been found in the side of a hill composed of sand and gravel. Not enough of it was seen to determine its character. No coal in place was seen.

The Cobalt Mining District.

Dr. Robert Bell.

This district has an area of about fifteen square miles and is situated on the line of the Timiskaming and Northern Ontario railway, its centre being three or four miles west of the northern part of Lake Timiskaming on the Ottawa river. Its surface is undulating, partly rocky and partly drift covered, and is well wooded. On the large scale, it has a generally even aspect and is interspersed with numerous small lakes.

The rocks of the district in general, provisionally classified with the sub-Huronian or Keewatin series, are mostly of igneous origin, consisting of granites, greenstones, agglomerates, volcanic tuffs, &c. and are favourable to the occurrence of metallic ores, should any veins exist among them. It was, therefore, considered to be only a matter of time in the evolution of the country from a state of wilderness, when important deposits of ores would be discovered anywhere among these rocks.

To the southward of the igneous rocks of the Cobalt district, quartzites, crystalline schists, &c., of Huronian age occur around Lake Temagami and southward, and still farther south quartzites of the same series, while still farther, in the same direction, several varieties of Laurentian gneiss are developed all the way to Lake Nipissing. To the northward of Cobalt, one large and several smaller inliers of unaltered, horizontal fossiliferous limestone of Niagara age rest upon the igneous and metamorphic series.

In 1887 and subsequent years, the writer made a geological reconnaissance of the region around Lakes Timiskaming and Temagami and westward. In November, 1905, and again in April, 1906, he visited the Cobalt mining district for the purpose of studying the rocks of this particular area and the modes of occurrence of the ores associated with them.

Native silver and its associated minerals were discovered early in the summer of 1903 by Messrs. McKinley and Darragh, at the southwest extremity of what is now called Cobalt lake. These men were then engaged in taking out ties for the new railway under construction. Having had some experience in prospecting, one of them, in breaking the rock at the southern angle of the lake, close to the right-of-way, discovered small pieces of a white metal embedded in it. On removing the moss and black loam in

the vicinity, numerous small thin blackened plates of this metal were found. About the same time, native silver was recognized in a vein at the northeast end of Cobalt lake and some large and small rough blackened nuggets of the same metal were washed out of the earth on the outcrop of the vein. The construction of the railway was, therefore, the direct means of making the discovery of what is turning out to be an important mineral district. The "finds" above mentioned, however, attracted but little notice, as the men who made them were directing their attention to the discovery of copper ore and not thinking of silver, none of which had previously been found in this part of Canada, and they were not impressed with the possible significance of what they had found.

In November of the same year, the attention of Prof. W. G. Miller, Provincial Geologist of Ontario, was called to this discovery and he paid a visit to the locality, returning with specimens of the silver and its associated ores. As these had been found in only two or three spots at that time, Prof. Miller could not forsee the numerous discoveries, over a considerable area, which have since been made, but he thought that the prospect already located was distinctly promising.

I considered the discovery sufficiently important to have it thoroughly investigated by the Geological Survey, and accordingly I engaged Prof. Parks, of Toronto University, to undertake the work immediately on the close of his college duties the following spring. In the meantime, the Ontario Government had sent Prof. Miller to the same ground very early in the season, (about the beginning of March). After Prof. Parks had worked for some time on the same ground as Prof. Miller, the latter proposed a division of their operations, so as to avoid duplication. As it appeared that the silver-bearing district might extend a considerable distance to the northward, he suggested that Prof. Parks should explore in that direction, while he himself would operate to the southward.

At the present time, openings, showing more or less native silver, have been made in probably nearly a hundred different spots within the fifteen square miles above mentioned as comprising the productive silver district of Cobalt. With few exceptions, these openings have been made in what is locally called a "conglomerate," but which is more properly an agglomerate, containing numerous irregularly distributed angular and rounded fragments, mostly of gray and red granite, and of the porphyrite itself in a somewhat soft bluish and greenish gray matrix of hornblende porphyrite or porphyritic tuff. The fragments are seldom large, and they are generally very irregularly distributed, partly in bunches, but in other parts they are sparsely disseminated.

The agglomerate has a general horizontal aspect, but there appears to be little or no evidence of aqueous stratification in the agglomerate itself, or of the action of water in the arrangement of the fragments, which are scattered through the mass at all angles. The weathered surfaces have the character and appearance of a volcanic rock and not of a conglomerate. The fragmental character of this rock prevails at the surface throughout most of the silver-bearing area, but, in the deepest workings, it shows a tendency to become non-fragmental. The colours of fresh fractures are generally bluish and greenish gray, but at some localities the colour is a dirty drab and, on close inspection, this shows a mottled character of lighter and darker shades. It is

doubtful if this agglomerate is equivalent to either the Lower or Upper slate conglomerate of the Huronian system north of the St. Mary river.

At some places in the district, the agglomerate passes into or includes fine grained gray or drab slaty rock, and at others gray arkose or greywacke, grading into a variety of impure quartzite. The total thickness of these rocks has not been ascertained. At the Larose mine, the upper stratum consists of about twenty-five feet of the fragmental agglomerate, underlain by an equal thickness of gray slate, which together form a cliff fifty feet high. The surface then slopes down from the foot of the cliff for thirty or forty feet to the collar of the shaft, which has been sunk on a group of small silver-bearing veins, separated from one another by the country-rock, and having an average width of four or five feet. At the time of my visit last November, this shaft had been sunk through the agglomerate to a depth of ninety feet, and a drift run for about 100 feet to the northeast and 350 feet to the southwest. The country-rock on either side of the vein was seen to carry metallic silver at many places throughout this length. At one point to the southwestward of the shaft, the vein-group bulges to a width of about twelve feet and shows distinct parallel veins in the roof of the drift. Within fifty feet of the southwestern extremity of the workings, at that date, the vein divided into two branches, both of which were rich in silver. During the winter the shaft was continued to a depth of 205 feet from the collar to the bottom of the sump, and at 200 feet, a tunnel was driven forty feet N. E. and 50 feet S. W. from the shaft. A winze was also sunk from the 90 to the 200 feet level, at a distance of 150 feet from the shaft. In the 200 feet level are two veins of calcite, separated by dark slaty country rock. This latter as well as the veins, is rich in native silver in the form of plates and rough nuggets. The rock breaks into lumpy schist-like fragments with smooth surfaces showing numerous thin leaves and scales of native silver on a large proportion of them.

Both the natural exposures and the artificial openings show that the agglomerate formation is divided into approximately rectangular blocks by two sets of dry vertical joints. Lines of fissure follow the courses of some of those joints and along those the mineralized veins occur. Their gangue consists of calcite. Sections of the veins are sometimes completely filled by metallic ores, especially smaltite or diarsenide of cobalt.

With the agglomerate and slate ash series, above described, are associated arkose or greywacke, quartzite and crystalline diabase. The slaty ash rock is not identical with true or argillaceous slate, but consists of the finer material derived from the modification by water of ashes and other volcanic materials, which became broken up and assorted when they came under the influence of the primeval sea. They are generally dark-coloured and obscurely banded parallel to the horizontal cleavage. In the country to the westward of the Cobalt district, along the Montreal river, around Lady Evelyn lake, &c., it is a common thing to see alternations of strata of considerable thickness, consisting of quartzites, arkose and this slate-like rock, which have evidently been separated by water from the volcanic materials that were being produced in abundance at that period of the earth's history and assorted into separate deposits of the coarser and finer materials.

The thickness of the agglomerate and slates, tuff or porphyrite probably varies considerably. At the Larose mine these rocks have a known depth of at least 295 feet,

Silver Nugget from the Larose Mine, Cobalt.

made up as follows: Upper half of the cliff above the mine, 25 feet of agglomerate; lower half of cliff, 25 feet of slates; slope from foot of cliff to collar of shaft, agglomerate about 40 feet; same rock to first level, 90 feet; from first level to bottom of sump, porphyrite tuff, 115 feet.

Along some of the joint-planes of either of the sets already mentioned as traversing the agglomerate, a disturbance accompanied by fissuring has occurred and these constitute the broken-up veins carrying the silver and other metals. It was observed that the stronger joints with slicken-sided walls often run in pairs close together, with a silver-bearing calcite vein in one or both of them. These joint-veins sometimes curve round through considerable angles up to 90° and they also give off branches. Examples of this may be seen at Little mine, from which a greater quantity of silver is said to have been extracted than from any other opening in the district. Some branching cracks, only about a quarter of an inch wide, filled with a fine red earth, run from one of the veins into the wall rock. This red earth was found to be very rich in silver, although no visible grains of the metal, or of any of its compounds, could be detected by washing it.

On the same vein which runs N. 23° W., a shaft has been sunk to a depth of 106 feet, from which a cross-cut has been made for 60 feet east and 70 feet west. The rocks cut by the shaft are blue agglomerate at the surface, followed by bright gray arkose, approaching quartzite, with an occasional rounded fragment of granite. Below this is the slaty rock which, on weathering, shows dull lines of stratification. Its colour is from dark bluish and greenish gray to nearly black.

Horizontal thrusts, dislocating the veins from two to ten feet, have occurred in some places. Examples of these may be seen at Little mine, Cobalt Hill mine and in the tunnel into the cliff just above the Larose mine.

A considerable portion of the eastern part of the Cobalt district is occupied by dark greenish-gray crystalline diabase in proximity to the agglomerate. In places this greenstone is probably intruded as dikes and masses in the agglomerate and its associated rocks; while in others it may occur as sills or overflows, lying in or upon these rocks.

Silver-bearing calcite veins, which also carry smaltite and resemble those in the agglomerate in some other respects, traverse the diabase at several localities in the district. Veins of this character occur on the following properties:—Violet or Handy, Welsh and Giles (north of the Foster mine), the Jacobs mine, the Hargraves, or McMillan, (south of the Jacobs). Diabase also occurs at the Watts or W. A. Allan mine. The Ben mine on the shores of Lake Timiskaming, now owned by Mr. Hotchkiss and associates, is in the agglomerate, but a greenstone rock occurs not far from it.

The majority of discoveries of silver, so far made in the Cobalt district, occur along lines running about northeast and southwest. But there is another set of veins crossing this course nearly at right angles. Two veins of this set traverse the property of the Larose Mining Company, the more northeasterly of which has been worked by running a tunnel along the vein into the cliff which rises a short distance to the south-eastward of the shaft. The other cross vein outcrops on the flat top of the hill at about 200 yards to the southwestward of the last. Here the earth has been removed so as to

expose the glaciated surface of the agglomerate. In one part of the smoothed surface, the vein shows itself as a reticulated shining streak of polished silver and rock, three or four inches wide. A neighbouring part of this vein has been opened and a considerable quantity of rich ore removed.

The silver-bearing veins of the agglomerate throughout the district are themselves small, but since much of the ore is derived from the branch veins and the country rock adjoining them, they are more important than might be supposed at first sight. The gangue consists of calcite, derived from the agglomerate, with rarely a little quartz. The vein-matter is generally much split up, fractured, faulted and brecciated and many miniature horses are included. Branches are sent off, which often follow the secondary dislocations accompanying the main disturbance that caused the vein. Yet there is usually a continuity of productiveness along the general plane of fracture. On either side of this broken-up and interrupted plane the wall-rock on either side may contain much native silver in the form of plates, sheets and leaves, filling small fissures or gashes.

The values are mostly in the silver, all the other ores being worth comparatively little. From the information I could gather as to the output of the different mines, the total value of the silver produced in the district, from the time the first openings were made until the beginning of April of the present year, amounts to upwards of $1,500,000 and it may approach, but does not exceed, $2,000,000.

The following twelve metals have been found in the veins above described :—Silver, cobalt, nickel, copper, lead, arsenic, antimony, bismuth, iron, manganese, zinc and, lastly, gold in small quantity in one or two instances. Most of these metals have here entered into numerous combinations, among themselves and with sulphur and oxygen, to form a variety of somewhat uncommon mineral species.

The presence of such a number of different metals is a hopeful sign and one of the proofs that the containing rocks are essentially of igneous origin, notwithstanding the local modification of parts of them by water.

For convenience, I use the word "mine" in the same sense as do the prospectors of Cobalt, namely, to indicate any artificial opening in the rock, such as a shaft, an open cut, &c., instead of restricting it to its true meaning.

The silver and the ores of the other metals usually occur irregularly in bunches or scattered through the calcite and also through the country rock between the small veins of the groups, as well as for some distance inward from the walls. Most of the metallic silver is found in flat plates with extremely ragged and irregular edges, which, judging from a parcel of 150 or 200 pounds in the office of the Nipissing Mining Company, will weigh, on an average, from one-quarter to one-half pound each. In the open cut, called No. 26, on this company's property, I saw, at a depth of 30 feet, a vein of coarse crystallized calcite 4 inches wide, thickly studded with bright silver to the extent of fully 20 per cent of its weight. Only 4 feet in height as rich as this was exposed, but it passed into the rock below maintaining its width and value. A specimen of this vein weighing 130 pounds was taken to the Company's office. Specimens of pure silver, weighing from a few pounds up to twenty or more, have been obtained in a number of

the mines and several pieces rich enough to be called "nuggets" have been found. A piece of rich ore, 5 inches thick and weighing 258 pounds, was found in the surface debris lying upon the outcrop of the Larose vein on the west side of the shaft. It originally formed a part of the full width of one "rib" of the vein and has a somewhat laminated structure, the layers being composed of smaltite, niccolite, native silver and calcite. This specimen was purchased for the Museum of the Geological Survey and, in order to ascertain the value of its silver content, five holes were bored through it. The drillings from these, on analyses, were found to contain about 18 per cent of silver. The high specific gravity of the smaltite and niccolite gave rise to a belief that this "nugget" might contain a larger percentage of silver. A mass of calcite and silver, said to weigh about 700 pounds, taken out of the Larose mine, was described as being so strongly held together by the silver as to require the use of cold chisels to cut it into pieces of convenient size to ship. "Nuggets" of mixed silver and calcite, weighing upwards of 100 pounds, are exhibited in the banks at Cobalt and in some of the mining companies' offices in the district.

As a striking example of the numbers of heavy pieces of native silver which may be picked out of the ore after it has passed through the crusher, I may mention that Mr. W. H. Linney, Superintendent for the Nipissing Mining Company, informed me that last year he had made a shipment to Mr. Ellis P. Earle, 31 Nassau street, New York, one of the partners in this company, of a petroleum cask containing 3,977 ounces of metallic silver and a large mass of niccolite with native silver protruding from it on all sides, and which was afterwards found to contain 780 ounces of this metal. The value of all, at 60 cents per ounce, was $2,854. At the offices of nearly all the mines in the district, the visitor is shown numbers of heavy pieces of native silver taken out of the respective mines.

The concentration of the silver in the metallic form near the present surface or at a moderate depth has no doubt been due to a chemical or electro-chemical process during a considerable period in former geological times, by which compounds of silver were reduced and deposited in their present form. It is not, therefore, to be expected that such heavy native silver will continue to any great depth. In the deepest parts of the Larose mine, 200 feet from the surface, a notable increase in the proportion of argentite has already taken place, dark red silver (pyrargyrite) has made its appearance and the changes due to surface influences in the wall rocks, gangue and ores, are less noticeable, as all these have assumed a firmer and fresher appearance.

The following notes on some of the individual mines of the Cobalt district are partly from personal examination and partly from descriptions given me by reliable persons, mostly the agents or the original owners of the properties. Up to the beginning of April, about forty different properties had been or were being worked. With three exceptions the depth attained was less than 100 feet, and in most cases it did not exceed 30 feet. At the Larose mine, the shaft (including sump) was 205 feet deep; at the Trethewey mine (J.B. 6) 100 feet, and at Little mine 106 feet. The company which has, so far, produced most silver is the Nipissing, which owns 900 acres of mining land to the southeast of Cobalt lake. Its mining operations have, as yet, been confined to one lot—R.L. 404—comprising only 10 per cent of the whole, but which includes the Cobalt Hill mine on its north side and Little mine in its southwest corner. Twenty-five

other separate openings have been made on this lot, all in agglomerate rock. They have been numbered in the order in which work was commenced upon them, and more or less silver has been extracted from each. Only three of these openings exceed 30 feet in depth. According to the records in the books in the local office of the company, these workings have produced, since operations began in 1904, silver, with a small proportion of other metals, to the value of $1,045,000, of which about $145,000 worth is still in the storehouse at the mines.

From Little mine, a shipment of 20 tons was sent to market a year ago. It assayed 4,800 ounces per ton. At 60 cents per ounce this amounted to $57,600 and was the best car-load which has yet been exported from the Nipissing Company's mines.

At the working on the Company's property, called No. 19, there is an open cut 50 feet deep and about 200 feet long with a breadth of 6 or 7 feet. It is said that out of this cutting 200 tons of ore were taken, worth $1,200 a ton or a total of $240,000, which is more than has been produced by any other single opening in the district.

In the southeastern part of Lot R. L. 404, and close to the shore of Petersons lake, are situated the open cuts called Nos. 12, 13, 15 and 21, at two of which work was going on at the time of my visit. Very rich ore has been found in No. 12, and the superintendent stated that $25,000 worth of silver had been taken out of it; also that some of the dressed ore of No. 13 assayed as high as 3,500 ounces per ton, and none less than 2,500 ounces.

Three car-loads of 30 tons each, or 90 tons in all, of cobalt and nickel ore were reported as having been sent last year from the Cobalt Hill mine. The Company received almost nothing for the nickel and arsenic contained in the ore. It was rather a singular fact that this ore contained less than half an ounce of silver to the ton. From the same mine, in 1904, the Nipissing Company's books show that 397,310 pounds of smaltite, containing only 5½ ounces of silver to the ton, were sent to New York. The heaviest single mass of cobalt ore found upon the Nipissing Company's land was in No. 8 open cut, which is about 100 feet long and runs about east and west, From this opening 132,000 pounds of cobalt ore, containing 10 per cent of the metal, were taken out. One large slab of solid smaltite was removed which was 16 inches in thickness and weighed over two tons. In this cutting, great quantities of cobalt bloom were uncovered along the south wall. The labourers threw it out in shovelfuls, in the form of a plastic mass.

The workings known as the Trethewey mines are situated on lots J.B. 7 and J.B. 6. Silver was discovered by Mr. W. G. Trethewey on both of these lots on the same day, 23rd May, 1904. The more northern lot, J.B. 7, which belongs to Mr. Trethewey personally, is called the New Ontario mine. The principal vein on this location is 8 inches wide and runs nearly east and west. A shaft was sunk upon it to a depth of 70 feet. On driving eastward at this depth, the vein soon forked. The drift was continued 40 feet on the northern and 190 feet on the southern division. This again split up into branch veins comprised in a breadth of 7 or 8 feet, between which the wall-rock was well charged with silver, and the small branches were also 'shot through' with the native metal. After much work had been done on the south fork, an experimental break was made

into its southern wall and after crosscutting only four feet a larger vein than the one being worked was struck, which materially increased the output. A good deal of stopping was done on the small veins and adjoining rock, and prior to November, 1905, 44 tons of ore which had been taken from these workings had been sent to New York in two cars and sold for $110,000. Two other car loads of lower grade ore were also sent. Immediately adjacent to the veins, the wall-rock holds sheets or plates and nuggets of silver. One of the former had a superficies of about 25 square inches. Some small boulders of granite, about the size of a man's head, taken out of the agglomerate had been fractured *in situ* and were penetrated by veins or sheets of native silver. The gangue of all the veins here is calcite and, besides the native silver, it holds smaltite and niccolite.

Captain Reddington, in charge of these properties, informed me on the 13th of April, 1906, that since last November, two car loads of ore had been sent to New York, one consisting of 28 tons of rich material, which sold for $68,000. The second car carried about 30 tons, but he had not, at that date, received the return for it. These shipments, together with some ore on hand at the mine will, it is said, make a total yield, so far, of about $200,000.

On lot J. B. 6, immediately adjoining, to the south, the property last described, seven silver-bearing veins have been discovered, all of which run nearly east and west. On vein No. 1, where the initial discovery was made at the time the claim was staked, a shaft has been sunk to a depth of 100 feet at a point 200 feet southeast of the 70 feet shaft above described on J. B. 7. From the bottom of this shaft a drift has been run 60 feet east and 40 feet west following the vein. The latter consists of a group of stringers, all much broken up and mixed with the wall-rock. Sometimes there is a streak of vein-matter on one or both sides of this group. Native silver, in the form of bright leaves, occurs in the rock among the stringers, but most of the metal is found in the walls adjoining them. Open cuts have been made on the other six small veins and native silver has been found in all of them in the form of large disseminated grains, which sometimes occur in considerable bunches. The largest of these open cuts is 50 feet south of the above shaft and is 70 feet long by 30 feet deep. The country-rock at the openings on both J. B. 7 and J. B. 6 consists of a blue-gray, soft, fine-grained or amorphous tufa, which, towards the surface, holds rounded and angular fragments of volcanic ash-rock and of gray granite.

Among other openings visited in this part of the district, were the Timiskaming and Hudson Bay and the McKinley and Darragh mines. The last named has been already mentioned as the site of the first discovery of silver in the district. Only a small amount of work had been done on this property, but an opening which had been made on a vein at the water's edge in the southern angle of the lake, showed a promising amount of native silver, together with some smaltite.

At the Timiskaming and Hudson Bay Company's mine the silver-bearing vein which was worked runs northeasterly and is four inches wide, with silver also in the walls. I was informed that here a stope, only 30 feet long and 25 feet high, had yielded two car loads of ore, which sold in New York for $32,500 and $7,000 respectively.

The Jacobs mine, already mentioned, lying to the southeast of Petersons lake, affords one of the best examples of a silver bearing vein cutting the dark greenish-gray crystalline diabase of the district. The vein, which is of calcite, runs north and may be seen along the west side of an adit which has been driven 120 feet on its course into the side of a hill. At first the vein is only two or three inches wide, but in advancing into the adit it is seen to increase to four and eight inches, and in one part, where it is split up and brecciated, it has a width of ten inches and holds bunches of native silver. In another part also the vein was observed to be rich in the metal. Higher up the hill, an open cut has been made along the same vein with a depth of 25 feet, for a distance of 70 feet, from which it is continued on the adjoining White-Hargraves property. Smaltite and a mineral like niccolite also occur along this vein.

The captain in charge informed me that 23 tons of ore, containing about 3,000 ounces of silver to the ton, besides a little cobalt, nickel and arsenic, had been shipped from the mine during the present spring; also that last year two car loads of ore had been sent from this vein and three from another one, which had been previously opened on the property.

Mr. Henry Richardson, manager of the McLeod and Glendenning (or Hanson) mine, informed me that two calcite veins occur on that property, 300 feet apart, both running northeast and southwest. The one to the northwest is in diabase and is rich in silver, with smaltite; while the other is in slaty agglomerate and carries no silver. The widest part of the productive vein is four inches. The mine consists of an open cut 60 feet long. Ten tons of ore have been shipped.

Mr. Richardson also informed me that the Violet mine, on the lot adjoining the Hanson to the north, is entirely in diabase. Some of the rock is here rather coarsely crystalline, while some of it is fine-grained and as darkly coloured as that of the Jacobs mine. The Violet mine has a shaft 90 feet deep and a cross-cut level has been started to the southward. A little silver ore has been taken out of an open cut. Both the Hanson and the Violet mines show a good deal of smaltite.

The Drummond mine is at the east end of Kerr lake. Here two smaltite veins occur about 8 feet apart. Between these, horizontal streaks of silver are found in the agglomerate which constitutes the country rock. There is an open cut about 20 feet deep and a shaft is being sunk.

The northern angle of the Lumsden and Booth, or Gillies, timber berth protrudes from the south into the centre of the silver district. This has not been disposed of by Government for mining purposes and it has not been referred to in the above descriptions of silver-bearing properties, although some rich veins are known to occur in it.

The number of veins or vertical zones of fracture carrying silver, which have been already found in so limited an area as the Cobalt silver district, must be considered large, and the question is asked—what are the prospects for further discoveries within the district in the future? Where so many discoveries have been made, while so large a proportion of the surface of the rock is covered with earth and this again by a thick growth of coniferous trees and deep moss, it is reasonable to expect that many more will follow when the timber is removed and extensive costeaning is undertaken.

The Nipissing Company is installing heavy machinery for the purpose of pumping water from Petersons lake to high levels, with a view to washing the earth entirely off the surface by the hydraulic process. This will allow of a complete search being made for the outcrops of the vertical silver-bearing zones, which are often inconspicuous at the surface and might escape discovery by the ordinary methods of prospecting.

From our present knowledge it would appear that the silver has a regional environment as well as certain local geological relations, resembling the mode of distribution of the richer nickel ores in the Sudbury district. There, outside of a certain area, although the geological conditions may be similar, no one ore rich enough to work can be found. Similar phenomena obtain in other parts of the world in regard to other metals, such as tin and mercury. Although diligent prospecting has been carried on throughout a large area outside of the silver district immediately around Cobalt, no discoveries of similar occurrences of silver have been made. I may, however, mention that traces of native silver have been discovered recently on the east side of Lake Timiskaming at a place which lies in a line with the northeasterly course followed by the successive silver mines in the centre of the Cobalt district. This discovery is close to the Wright silver-lead mine, which is in a very pronounced volcanic agglomerate. A thorough exploration of this part of the lake shore and the country behind it might bring out interesting results.

Small quantities of smaltite have, however, been found in different localities beyond the silver district. It now appears that the silver is not necessarily connected with this mineral. It has been mentioned on a previous page that in the Cobalt district the largest bodies of smaltite so far tested contain only traces of silver. Unless the conditions necessary for the production of the silver itself are repeated in some other locality no further important discoveries of this metal may be made in this part of Canada.

One of the most vital questions in connexion with the silver mining in the Cobalt district is that respecting the depth to which the deposits may continue. The direct evidence afforded by the main vein of the Larose mine carries us down only 205 feet from the collar of the shaft, but the silver-bearing character of two other veins, which cut the 80 feet of agglomerate, &c., above the level of the collar, may be considered in this connexion, which would give us a depth of nearly 300 feet. The ore and rock brought up from the lowest workings of this mine show that the vein has undergone no material change so far, being about equally rich and varied in its contents all the way down; but, as above mentioned, there is in the lowest workings an increase in the proportion of argentite, and the vein and its walls have a firmer and fresher character. Good sized flattened nuggets continue to be found among the native silver. At the 800 feet level the line of fracture is marked by two parallel calcite veins of 5 and 7 inches respectively, separated by an interval of slaty tufa, rich in native silver, which also extends, as thin plates, into the wall-rock on either side, as far as four feet in some parts.

It may be reasonably supposed that the farther a vein can be traced on the surface, the deeper it is likely to go. Although nearly all the individual veins are small, they may be regarded as only one manifestation of a mineralized plane or zone of fissure or disturbance. The fact that these fissure-planes, or lines of fracture, are

vertical, and that they coincide with the prevailing system of strong joint-planes are circumstances favourable to persistence in depth. The agglomerate and its associated rocks have been found, by means of the shaft and boring at the Larose mine, added to the height of the rocks above the shaft, to have a depth of at least 300 feet, but it may be much greater than this. The thickness of the jointed agglomerate may be found to have some influence, not only on the depth of the fissures, but also on their argentiferous character, as the silver appears to have been derived from the country-rock in which the veins occur. If the veins prove to pass down through the agglomerate into some underlying rock their silver contents may continue downwards with them.

If a comparison be made between the geological and mineralogical conditions at Cobalt, and those of the Thunder Bay silver region, it will be found that there are more points of difference than of resemblance in regard to the principal group of mines in the latter region, which embraces the Rabbit Mountain, Silver Mountain, Porcupine, Beaver and West End mines. In all these the silver occurs, both native and as argentite, in well-marked brecciated veins of quartz, which cut down through a heavy sheet of diorite into a great thickness of darkly coloured unaltered shales, lying horizontally. These belong to the Animikie series, which is much newer than the rocks of the Cobalt district. The conditions at the Shuniah and Thunder Bay mines a short distance northeast of Port Arthur, have some resemblance to those of the mines just mentioned, and both of them were rich in native silver at the surface, but on sinking, it soon gave out. At the Silver Islet mine the conditions were quite different. A broad dike of a peculiar variety of diorite, which can be traced for miles parallel to the northwest shore of Lake Superior, cuts through a great thickness of nearly horizontal gray and nearly black unaltered shales. A very strong vertical calcite vein cuts this dike almost at right angles. Except where traversing the dike, the vein holds nothing but a little galena. But the part which lay within the dike, and constituted a perpendicular square prism, proved to be rich in argentite and native silver, to a depth of about 1,000 feet, when it began to fail and at 1,200 feet it had become so poor as to be no longer worth working. The total value of the silver taken from this mine amounted to about $3,250,000. The rock of the dike itself, on analysis, was found to contain a variety of metals in notable quantities.

On the shore of Thunder bay, a short distance to the northeast of the Shuniah and Thunder Bay mines, a rather small vein which cuts both the Huronian and Animikie rocks was worked to a limited extent under the name of the 3A. mine. It was noted for producing occasional specimens of nickelite.

Silver Nugget from the Larose Mine, Cobalt.

Geology of Parts of the Counties of Labelle and Wright, Quebec.

Professor Ernest Haycock.

Pursuant to instructions from the Acting Director, I left Ottawa on June 17, to continue mapping the rocks of the 'Lièvre River and Templeton Phosphate District.' I was accompanied for the season by Ralph K. Strong, B.A., who proved a most efficient and valuable assistant.

The map of the district includes all the township of Portland, the northern half of Templeton, and the northwestern third of Buckingham. Small portions of the townships of Hull, Wakefield, Denholm, Bowman, Villeneuve and Derry also lie within its borders. The area measures approximately fourteen miles east and west, and eighteen miles north and south, or about 250 square miles.

Work was begun around the northern arm of Wakefield, or Big Blanche lake, and an effort was made to trace to their disappearance, or to the limits of the map, the limestones and gneisses which here trend northerly. Finding the rocks traceable, this method was continued, and the country to the east of the Lièvre was thoroughly examined, the distribution of the more conspicuous belts being ascertained. The remainder of the season was mainly spent in examining the township of Buckingham. On the close of field work, Sept. 26th, I returned to Ottawa.

Throughout the area thus examined the rocks found were in general similar to those described in the Summary Report for 1904, pp. 233-238. Some important variations in texture, mineralogical, and chemical composition were observed, which, with the surface distribution, have a bearing upon questions of origin. These will be briefly referred to as each group is taken up, but no extended discussion of group relations or theoretical questions will be undertaken here. With a view to giving this report a practical character, the groups will be designated by their predominant economic or mineral characteristics where possible, or by the numbers under which they are described in the report cited.

Part I.—Western Part of the Northern Sheet.

Asbestus-bearing Rocks, mainly Crystalline Limestones.

These rocks occupy a relatively large area in the northwestern part of the district. In a narrow band they enter the district just south of St. Pierre de Wakefield, in the little valley of Pelissier creek, lot 28, range xiii, Templeton. The brook flows along the northwest contact with gneiss and intrusives, and limestone can be seen at intervals for a few rods up the slopes to the southeast. It is rich in secondary graphitic minerals, and passes into serpentine and pyroxenite along the contact laid bare by the brook. Asbestus occurs in this contact zone in thin sheets or rudely concentric layers, exactly as described by Dr. Ells for typical occurrences about Perkins Mills*. Some develop-

* Annual Report, 1899, vol. xii, pp. 105-106.

ment work was being done here in June with a view to testing the deposits for paying quantities of the fibre, or of less pure asbestus rock. The limestone here trends northeasterly, but disappears beneath sandy deposits. Half a mile north on lot 26 range iv, Wakefield, it appears again, graphitic, with pyritous sandy layers, rusty-weathering, in good exposures on the hill slopes a little west of the post road. It disappears again in swamps and wooded country, and reappears nearly a mile to the northeast, on the northern part of lot 29, range iv, Wakefield, though the low land between, and occasional limestone boulders in the soil, leave no doubt of its actual continuity.

From this point there are practically continuous exposures, over a belt of country from one to two miles wide, for about four miles, to near the northeast end of Wakefield lake. The surface is moderately level, generally cultivated, or occupied by the various extensions of the lake. Siliceous bands and intrusives are not uncommon, but the predominating rock is limestone. Asbestus has been reported in small quantities from various localities in this area, and is liable to occur wherever the conditions have been favourable, as at contacts with the gneiss or intrusive masses. On the northern parts of lots 28, 29, 30, range IV, Portland west, the belt abruptly terminates or is cut off squarely by hills of gneiss. No direct continuation in this direction, even in diminished volume, could be found.

Westwardly, the banded gneisses, trending northeasterly, are crossed for about half a mile from the lake, when the limestone is met with reaching beyond the borders of the map and comparable in width with the belt to the east of the lake. It extends north and east, but is cut off abruptly to the south by well bedded gneiss. The juncture is broken and irregular, and suggests fault displacement.

Followed northerly, this belt shows the same characteristics as the lake belt; the limestone is graphitic; asbestus is common along the contacts; and thick interbedded sheets of quartzite, garnetiferous gneiss, or more sandy pyritous and rusty-weathering gneiss, occur, but are generally too much broken and concealed to permit of continuous tracing; for this belt is rather easily weathered, soils and surface deposits are deeper, and exposures much less frequent and continuous than in the rugged and hilly country underlaid by the more resistant gneisses and intrusives. Showing these dominant characteristics this belt of rocks widens out beyond the western margin of the sheet, apparently bounded by a range of abrupt hills not more than one or two miles away. It reaches the northwest corner of the map and then sweeps southeast and east, sending a tongue north over the boundary to Escalier lake, and then sweeps south and southeast.

Near Hollands Mills post office the belt is quite narrow, certainly less than half a mile in width, but it widens to about three quarters of a mile and holds this width nearly to McFee lake on the southern margin of the map. North of this lake it is cut up by the intrusives and nearly disappears. The remnants bend eastwardly, but are not again seen on the west side of the Liévre. A sharp valley one quarter of a mile wide leads out to the river flats between rugged bluffs of coarsely crystalline rocks. It is occupied by Ryans creek, and the bottom is filled with deposits of clay. The limestone band may pass through this gorge and reach the river. The existence of the valley favours this view, but no direct evidence was obtained.

This belt of rocks, of fairly constant composition and structural characteristics, was traced continuously for about twenty miles, and with slight breaks, some five miles farther. They form an ox-bow area very much widened out at the bend.

North of Wakefield lake, and south of Hollands mills, asbestus is found in small quantities. Dark coloured, pyroxenic masses occur about Poltimore, very irregular in outline and probably intrusive in the limestone. They yield rather dark-coloured mica. One of these deposits on lot 48, A. Denholm, was being opened up, but no others were being operated in July.

Hornblende Gneiss.

As No. 7 of the important rock types met with last season, a coarsely crystalline rock, composed mainly of a gray feldspar and abundant hornblende, was described as occurring east of Wakefield lake and extending beyond the northern boundary of the southern sheet. A similar rock was noted south of McFee lake.

Its continuation northward was taken up this season, and though not continuously traced, it was occasionally found lying immediately east of the west arm of limestone. The country is rugged and quite densely wooded and the dominant rock is not easily determined.

South of Hollands Mills P.O., a low ridge runs along lot 14, VII, with good exposures for its whole length of nearly half a mile. Its eastern slope is of limestone, with rusty gneiss and pegmatite inclusions. It dips east at a high angle. Well banded quartzite and gray gneiss, a few feet in thickness, lie next the limestone, and just beneath is a belt of granitoid gneiss fairly uniform in texture and composition. The foliation is parallel with the bedding of the quartzite and limestone and there is a tendency to massive bedding parallel with that of the supposed metamorphosed sedimentary rocks. It appears to be composed mainly of a gray to reddish orthoclase, black hornblende, and a very little quartz. Similar rock crops out west of the post road on 16 and 15, VII, and trends south just to the west of the limestone. East of McLeod lake more free quartz was noted and the composition approaches that of hornblende granite. It was then traced southwards, with continuous exposures in burned country, without a break, and found to connect with the previously known area south of McFee lake, which bends around east and northeast to Dodge lake. Passing southwards, the feldspars lose their reddish tints, hornblende is more abundant, foliation more general, and the rocks become dark gray in colour and less like granite in texture.

From the continuity of these rocks on the east, and their known occurrence on the west, it seems almost certain that a similar continuity must exist there, escaping detection on account of the slight changes in mineralogical composition, and the difficulty in determining the dominant rock where the surface is thickly wooded. The fault displacement that disconnects the limestone belt would also break up the continuity of the granitoid gneiss. A corresponding displacement occurs on the eastern side, apparently less in amount than on the west, but pushing the limestones to the east of Lake Terror when the previous trend would have carried them west of that lake. The sharp break previously mentioned as occupied by Ryans creek is in line with this line of displacement.

These rocks thus form a roughly concentric belt within the bow-shaped belt of limestones, and follow closely its inner edge.

Their appearance last year, when this singular distribution was not known, was thought to be more consistent with an igneous origin, even though a heavy bedding was discernible. The additional facts confirm the view that they were originally sedimentary or, at least, bedded rocks without pronounced differences of composition in contiguous beds, lying above, or perhaps below, the limestones and subsequently folded in with them. Their thickness is not great, probably averaging a few hundred feet. They are generally barren as regards economic minerals.

The Banded Gneiss, or the Mica-and-Apatite rocks.

Under this heading are included No's. 1, 2 and 3 of last year's report. They are banded or bedded rocks, hornblendic, garnetiferous, or quartzose, regarded as of sedimentary origin, differences in composition being ascribed to the varying character of the accumulating sediments. Although the general trend of these rocks in the south is northeasterly, an extension northerly and northwesterly with interbedded sheets of limestone was traced along Grand and McArthur lakes. These were, this season, traced several miles farther north, crossing ranges III., IV., V. and VI., in Portland west. The bedding is well defined and rather free from twisting and contortion. The strike is approximately north and south with high dips to the east. Garnetiferous gneiss is common. The limestone bands of the lakes are somewhat centrally located. They disappear a short distance north of McArthur lake.

Numerous trial pits and old workings for mica and phosphate are found in this area. None are now being worked but they are said to be by no means exhausted. All the deeper workings being filled with water were inaccessible to observation, but superficial appearances favoured this view.

Phosphate rocks of the Lièvre river.

Elevated rough and hilly country shuts in the limestone area first described. The river swings southwesterly across the strike in the southern part of the sheet. A sharp break occurs in these hills where Priest creek enters from the northwest; a broader hollow runs north to Escalier lake, occupied by a tongue of limestone; and quite a broad gap occurs on the east opposite Notre Dame de La Salette. No limestone was found passing through the gap opposite La Salette.

This area was not given as thorough an examination as those previously described. It was studied by E. D. Ingall and others while the mines were in operation and the facilities for observation much better than at present.

Enough was seen of these rocks, however, to lead to the conclusion that they belong to the banded gneisses, with considerable volumes of various intrusives. Some of these are massive and granitic in character, as at High falls, where a massive band of these rocks parallel in trend with the gneiss crosses the river in a northeasterly direction, giving rise to these beautiful falls.

The prevailing strike is parallel to the contact with the limestones of the large area already described, and the belt is thought to be closely related to, if not a part of, the same series.

Only two bands of limestone were seen within this river belt. One comes from the northeast on the west side of the river and continues southwesterly and occupies the north side of Barbut lake. It is nearly a half mile wide at the north end of the lake, but is barely to be found at the south end. In this diminished volume it was traced to Central lake, but was not found beyond. The second band lies about a quarter of a mile east of the other, in the bend above the first rapids. It is only a few rods wide, and runs parallel with the first band and the accompanying gneiss, or northeast and southwest. It was traced about half a mile to the southwest, but was not seen beyond.

It may be mentioned that a well marked longitudinal valley runs the whole length of this loftier northern part of the river belt to its termination at the gap opposite La Salette, and it was confidently expected that the limestone band of Barbut lake would be found at intervals along this hollow. Though it was not found south of Central lake, it was not proved to be absent, and may with diminished and irregular widths occur at intervals, and form a softer band which by more rapid weathering has given rise to a valley. Quartzite and garnetiferous gneiss were noted bordering a swampy tract at its southern extremity. Mr. J. F. E. Johnston noted small outcrops of limestone on the road running south on the west side of the river from Chalefoux's landing towards Priest creek (Sum. Rept. 1904 p. 245), which would correspond in position with the continuation of this band.

As previously indicated, none of the phosphate mines are now working. The roads are becoming choked with undergrowth, old mine buildings are tumbling down, yawning pits partly filled with stagnant water confront one in the bush, and a general air of desolation prevails. A few tons of apatite are, however, taken out yearly by individual workmen, who claim that by working over the richer parts of the old dumps, or by taking out small richer pockets of the ore, the work pays at the present prices, where, with larger gangs, poorer rock would have to be worked and it would be impossible to make wages. This erratic method of working must be relatively expensive, and its paying in a small way raised the question whether there was not a gleam of hope for the future of this abandoned and agriculturally worthless section.

The foregoing discussion sets forth the more outstanding features of the country rocks and the dominant character of the surface of the northern part of the district between its western boundary and the Lièvre. Contortions and twistings are frequent and often confusing, but the prevailing strikes can in general be made out corresponding well, as would naturally be expected, with the surface trend of the belts. The dips are almost invariably high, less than 45° being very exceptional, while from 60° to 90° is the rule. The prevailing direction is to the east, the limestones on both sides of the ox-bow belt described dipping beneath the bedded gneisses. The strike of the gneisses of the hills about Mud lake, north of the limestones, in Bowman, is east and west, vertical or north dipping, but no contacts were seen there and the relation is not known positively. In spite of the broken and minor irregularities of distribution, when the outcrops are coloured upon the map now in preparation, as they were while on the

ground, and when nearly the whole area can be swept by the eye, as it can be from the hills about High Rock, minor irregularities are merged, or lost sight of, in the more general features and it seems easy to see a definite distribution which is susceptible to structural explanations.

It is assumed here that these rocks are the metamorphosed representatives of once stratified sedimentary series, conformable or with no great unconformabilities. Then the following explanations may be offered with a considerable degree of probability. That the series have been crushed into a closed or isoclinal fold and overturned slightly. That it is either anticlinal with an axis plunging north, or synclinal with an axis plunging south. If the former, the garnetiferous gneiss and axially lying limestones of Grand and McArthur lakes are the underlying and oldest portions; if the latter, then the apatite-bearing-belt along the Lièvre becomes the oldest, and the limestones of those lakes the uppermost members. The occasional synclinal tendencies of the lake limestones rather favours the latter view. The interpretation has a bearing upon the age of the rocks in the area to the south, in general trending northeast and southwest, and which these widen out and join.

The intrusives of this area are both varied and numerous, but of types discussed somewhat in the report of the previous season. There are no bodies sufficiently extensive to require special mention here. Pyroxenic rocks are of frequent occurrence. The lighter coloured usually lie near the limestone bands, or in their continuation, and some additional facts bearing upon their origin were noted.

Eastern part of the Southern Area.

In connextion with No. 9 of the rock types mentioned in last season's report it was stated that a boss of coarsely crystalline basic rock lay east of Grand lake, and was traced northeasterly as far as Newton lake. Its continuation was found on the northwest side of Newton lake and on both sides of Farley creek. It is coarse and even porphyritic in places, generally lighter in colour and more acid in composition than the portions seen last year.

It passes beneath the clay of the river banks, but has not been looked for east of the river.

Mica and Phosphate belt of Banded Gneisses.

At the outlet to Newton lake and along the portage to the Lièvre a thin band of limestone is exposed at intervals, interbedded with banded gneiss. This band was traced almost continuously from McGregor lake. It marks the northern border of the mica and apatite bearing belt of banded gneiss and intrusives which was described in last season's report. This belt is cut at right angles by the Lièvre river, and is about six miles wide.

Apart from local twistings the strike is north 40° to 50° east vertical, or with high dips. Quartzites are abundant, often weathering rusty from contained pyrites. Limestone bands are thin and infrequent. One was traced from Maskinonge lake for two and a half miles to its disappearance beneath the clay of the river, and was found again

at Trout lake one and a half miles to the northeast. There are traces of two or three other broken bands, but their volume is relatively very small.

A large mass of granite occurs about Davis lake, lots 12 and 13, range I, Portland east. Portions are without foliation. The rock is made up of feldspar, hornblende, a little biotite and considerable free quartz. The texture is that of normal granite. The texture, however, is finer near the banded rocks, and they are much broken and fused near the granite. The composition is much the same as the rock described as No. 6 in the Report for 1904, which occurs in the hills north of McGregor lake, and about Dam lake, though the massive character is much more pronounced at Davis lake. It is not unlikely that they are superficially separated portions of the same rock magma.

Mica occurs abundantly throughout this belt and apatite is often associated with it.

Two new openings had been made in the district since last season, one east of Sucker lake on lot 7, Gore of Templeton, and another north of Plumbago lake in lot 2, range X, of Templeton. Some good mica had been taken out, but work was not going on when they were visited. At the excellent prospect opened up last season, just east of Dam lake in the Gore, work was reported as held up on account of legal disputes. The quantity taken out was not ascertained.

The following information was furnished respecting the work done by the Wallingford companies. 'The Wallingford Bros. Ltd. have opened up the property, east ½ of lot 1, range I, Portland east, partly developed by Mr. Poupore in 1893 and again worked in 1900, and have done a considerable amount of prospecting, developing several leads of fine mica. The same company also did a good deal of work at the Denholm mine. The Wallingford Mica and Mining Co. have extensively developed both at old Wallingford mine near Perkins Mills, and the Battle Lake property. The merchantable mica shipped totals up 40,000 lbs. besides about 200 tons of phosphate which was taken out in the course of mining the mica.'

The Blackburn mine was not visited nor was any information obtained as to the recent progress of the work there.

Graphite belt of banded gray gneiss with numerous limestone bands.

The mica bearing rocks pass southeasterly into grayer, less quartzose, more pyritous and calcareous, bedded rocks, parallel in trend and structurally similar to the mica belt. Mica and apatite, are, as a rule, absent, but graphite is of frequent occurrence, and several deposits of graphitic gneiss occur.

This belt of rocks occupies the remainder of the district, being at least five miles wide. It joins the mica belt on the east side of Plumbago lake, and runs northerly a little to the east of the Templeton and Buckingham township line. On range VIII of Buckingham it bends to the northeast, crossing range IX and reaching the Lièvre about the middle of range X. The trend of the rocks to the southeast is roughly parallel with this line. They run north for two or three miles and then bend around to the northeast, continuing to and beyond the area visited.

The volume of limestone is considerable. It appears to be interbedded with the gneiss, and is pretty widely distributed, being found in nearly all the larger outcrops, except where the volume of certain rocks regarded as instrusives is large. It is thus found, almost continuously, from the western extremity of Donaldsons lake eastwards in ranges V and VI, and from lot 17 eastward in ranges VII and VIII.

Two areas of the interbedded gneiss and limestone, separated by intervening masses considered as intrusives, were traced north and east from the vicinity of Donaldsons lake. On the eastern band are the workings of the old Walker property lot 19, VIII, and on the western near Donaldsons lake are two other graphite properties. The immediate vicinity of each of these workings has been mapped by J. White and A. A. Cole and the results of a study of the occurrence of the graphite, by the latter, are given in the report of the Mines Section of the Survey for 1897 (Report S. pp. 66-73.)

The rocks separating these areas from each other and from the broader river area are of a wholly different character. They appear to be a quartz-free admixture of gray and red feldspar and black hornblende, often very coarse, as on lots 19 and 20, range VII. In the extension of this mass northwards and in the bordering zones they become finer in texture and more banded, as though intimately injected between the layers of the banded gneiss but cutting across them freely. This band forms the rough and hilly country bordering the river flats on the west in ranges VII, VIII, and IX. It reaches and crosses the river on the southern part of range X, but in diminished volume. Southerly the rock does not reach the road on range VI.

The second mass was met with between McLean and Devine lakes. It runs southwesterly to the concession line between VII. and VIII., lots 23 and 24, and was traced southerly to range VI. It does not reach Donaldson lake in any notable volume. On the post road, a mile and a half northeast of McLean lake it was not identified as a separate mass.

These rocks in themselves appear entirely barren of any minerals of economic value, but if the interpretation offered as to their intrusive relations with the graphite-bearing rocks is correct, they may have a very close connexion with, and relation to, the graphite deposits in the immediately adjacent calcareous bands.

In the graphite industry no new mines have been opened since A. A. Cole's report, previously cited, was written. At Donaldson lake preparations were being made for resuming work on the property on lot 28, range VI. Nothing was being done on the adjacent property, lot 26, and the buildings appeared to be getting out of repair. At the old Walker mine, lot 19, range VII., the mill was being put in good repair, new machinery was being installed, and there was every outward indication that this property would soon become an active producer.

St. Bruno Mountain.

Dr. J. A. Dresser.

Four weeks of the last season were spent in the examination of some parts of the counties of Wolfe, Arthabaska, Drummond and Megantic ; this examination was necessary for the completion of the mapping of the copper-bearing rocks of the Eastern Townships. The boundaries of these rocks were traced through portions of these counties, and several occurrences of copper were examined. Amongst these a prospect of some promise occurs on the farm of Georges Lemieux, in range VIII., lot 1, Wolfestown. The ore is chalcopyrite and occurs in several stringers in three feet of dolomite, near the contact with a basic volcanic. In lots 5 and 6, range V, Chester tp., Arthabaska co., an open cutting fifty feet long has been made in a rock bearing chloritoid, similar to that which occurs at Harvey Hill, in Leeds tp. A mass of quartz three feet wide, and conforming to the foliation, carries bands of chalcocite, some parts of which are five inches wide. The work has been done by Mr. Stevens of Windsor Mills, Que.

On the sixth lots of ranges II. and III. of the same township a small amount of chalcopyrite two inches wide by two feet long, was visible for a time. A cutting of less than two feet into the rock removed all the ore as far as could be seen at the time of my visit. I am credibly informed that this property has been sold for $12,000, $3,000 of which has been paid in cash to parties in the state of Connecticut, and that a joint stock company capitalized at $500,000, has there been formed to acquire and operate the property. This occurrence, like many other copper stringers throughout this belt, is of no economic importance.

The remainder of the season was occupied in petrographic examination of St. Bruno mountain, or Montarville, one of the Monteregian hills. The examination of this series of remarkable volcanic hills was begun some years ago, but has been suspended for the past three years. The hills are eight in number, of which four have been petrographically examined in recent years, viz. : Mount Johnson, by Dr. F. D. Adams, as a private research, and Yamaska, by Dr. G. A. Young, and Brome and Shefford mountains by the present writer, for the Geological Survey. St. Bruno, the examination of which is now about finished, will thus be the fifth of these hills to be completed. Besides these, two others are already in course of examination, so that the investigation of the series should soon be completed.

St. Bruno mountain is the first of the Monteregian hills east of Mount Royal, and is fourteen miles from Montreal, in the county of Chambly. It occupies rather less than three square miles. Rising from the St. Lawrence plain, which here has an elevation of 100 feet above sea-level, this hill gradually attains an elevation of 560 feet at the northern side, two miles distant. The northern side presents a steep, cliff-like face more than 300 feet in height. This type of profile, an abrupt face on the north with a gentle slope towards the south, is characteristic of the Monteregian hills. Its cause is a physiographic question yet to be solved.

The sedimentary rocks around St. Bruno have long been regarded as belonging to the Lorraine formation, but in order that a detailed examination of their fossil contents might be made, a collection of fossiliferous rocks was obtained from various points. The specimens now await determination in the palaeontological department of the Survey. In making this collection, as well as in several other parts of the season's work, I was very efficiently aided by Mr. Robert Harvie, jr., student in Applied Science at McGill University.

St. Bruno mountain is composed of an intrusive mass of igneous rock, surrounded by a rim of hornstone, which has been formed by the alteration of the sediments adjacent to the intrusive. The igneous rock has the general character of essexite, an seems to have been wholly formed at one period of intrusion. In one part, less than an acre in extent, the rock becomes a light-coloured syenite, and in other portions it becomes very basic, containing large amounts of pyroxene and olivine. A suite of specimens for thin sections has been collected and will be studied in detail later. Specimens for chemical analysis are also in the hands of Mr. Connor, of the chemical staff of the Geological Survey.

Sheets of the igneous rocks frequently penetrate the hornstone rim near the base of the mountain, and dikes are common in the hornstone and less altered sediments, but are rarely, though sometimes, found in the igneous rocks. Some of these apophyses furnish interesting studies in rock differentiation.

The topography of the mountain is such as to give it an imperfect drainage. Its surface is very uneven. The coarse-textured parts seem to disintegrate more rapidly, and thus basins are formed which give rise to numerous small lakes. The largest of these are known locally as Lac Seigneurial, Lac à Daisy, Rond Eau, Lac des Atocas, and Lac des Ormnes. Most of these are drainage lakes, apparently, but two of the larger, Lacs Seigneurial and Rond Eau, give evidences that they are in part fed by springs. The present relief of the mountain is wholly due to the removal of the surrounding sediments by erosion and denudation, and to the better resistance to these agencies by the igneous and altered rocks, chiefly by the hornstone rim. It is thus a residual hill of the butte type.

The strata surrounding this mountain are nearly horizontal and would indicate that as far as the present surface is concerned the igneous mass is a filled neck but whether the neck ever reached the earlier surface as a volcanic vent, or merely led to a larger subterranean body, or laccolite, above, it is not easy to determine from present evidences. Remnants of hornstone are so numerous on even the highest part of the mountain, that the conclusion is difficult to avoid that they once completely covered it. On the whole, perhaps, the most probable view is that the syenite area, northeast of Lac à Daisy, represents the actual pipe of a volcano, while the remaining part of the mountain has been formed by laccolithic off-shoots, and outward magmatic stoping.

Rougemont, one of the Monteregian hills, stands between Beloeil and Yamaska. It is in the county of Rouville and has an area of some six square miles, with a height of about 1,400 feet. The igneous rocks, which are intrusive through the sediments, are all phases of essexite, as far as yet known, except some dikes and irregular masses on the summit, which are fine textured, and evidently contain large proportions of iron.

On the Whitfield farm at the south side of the mountain, the strata dip away from the igneous rock at an angle of 10 degrees, but at about 300 feet from the contact they seem to suffer a sharp anticlinal fold, and dip towards the mountain at a higher angle than they before maintained towards it. In the brief examination of the locality, which was made only for comparison with St. Bruno, it was not learned whether this structure is general around this mountain, or not.

The Valley of the Tobique River, N.B.

Professor W. A. Parks.

Acting on instructions received from the Director of the Geological Survey to examine a portion of northern New Brunswick, I proceeded to St. Stephen, N.B., for outfitting purposes and thence to Plaster Rock, where I was fortunate in procuring, without any delay, the services of two good men.

The operations of the party were confined to the region adjoining the forks of the Tobique river in Victoria county. A section of country stretching northeast for about thirty miles, with an average width of ten miles, was examined as carefully as time would permit. Owing to the unprecedented lowness of the water in the Tobique river, travel by canoe was quite impossible, so that access to the different parts of the region could be gained by overland expeditions only. The topography of the region has been well determined by previous investigators, but some additional information was obtained concerning the course of certain streams. Track surveys were also made of several bush roads in the eastern part of the area.

The whole region is very rough, with numerous well-defined hills showing a relief of 1,500 to 2,000 feet. All the important elevations were ascended, and numerous barometric readings were obtained. From these results, and from sketches obtained from the hill tops, data are available for the construction of a contour map of the area.

The rough character of the section makes it unsuitable for agriculture; this is particularly true of the region south of the Tobique river. At various points along the river sufficient alluvial deposits have accumulated to make farming not only possible but lucrative. North of the Tobique, and along the valley of the Mamozekel, excellent clay loam overlies the rolling Silurian rocks and will doubtless prove a profitable field for the agriculturist. The timber is very diversified in character, presenting a mixture of hard wood with coniferous trees; among the former are maple, beech and elm, as well as the semi-hardwood, birch. The coniferous trees are represented by white and red pine, spruce and balsam. The writer, familiar with northern Ontario, was impressed by the profusion of yellow birch and the total absence of the Banksian or pitch pine. Practically all the pine has long since been harvested from the area, but much excellent spruce, yellow birch, elm, maple and beech still remain. Forest fires, particularly the so-called Tobique fire of about forty years ago, have devastated large sections of the area examined.

Geology.—The geology of the region is very interesting, but somewhat difficult, as is shown by the diversity of opinion expressed by different authors. The present writer hesitates to express an opinion as, in his judgment, the question rests with the microscope for its solution. Pending the examination of rock sections, it may be stated that the following series of rocks are found within the narrow area examined.

I.—Various Archæan crystalline schists and eruptive granites. These rocks are exposed on the Serpentine river near the mouth of Boover brook and in the region to the southeast.

II.—Fine fissile slates with graphitic markings and possibly the remains of organisms. These rocks are probably referable to the Cambrian and are best exposed on the Serpentine to the north of the Archæan region and in the upper part of the valley of Four Mile brook (Serpentine).

III.—Hard slates and sand rocks, bent into abrupt anticlines and synclines, in places showing strong induced schistosity and in others presenting a much less altered aspect. This series is wide spread, particularly to the north of the Tobique and has been referred to Silurian age.

IV.—A well marked and persistent, if narrow, bed of conglomerate. The best exposures are seen on the right hand branch of the Tobique, just above the mouth of Jummet brook. It seems to overlie the Silurian slates and sandstones and is to be observed on the crests of the anticlines farther down the river. This rock can be traced from a considerable distance west of these outcrops clear across to the Serpentine and some way up the valley of Four Mile brook on that stream.

V.—Volcanic breccia? It is a significant fact that this conglomerate is, *in almost every instance*, overlaid by a red spotted rock with an apparent clastic origin; awaiting the examination of sections it is best described as above, with a query.

VI.—Slates and hard sandstones. This series of rocks follows that last mentioned and is best exposed on the right hand branch of the Tobique to the southward of the breccia. Hand specimens of these rocks are not to be distinguished from the Silurian series, but many fossils are to be found, which are apparently of Devonian age. The fossils are mostly minute and badly preserved but they exactly resemble specimens from the hard Devonian series of England. *Despite careful search no fossils were found in the slates and sandstones to the north of the vicinity of the conglomerate and breccia.* This statement does not mean to the north of Jummet brook, for, as above mentioned, occasional indications of conglomerate were seen almost to the mouth of the right hand branch. As long as any trace of conglomerate was visible occasional fossils were found, but beyond the conglomerate the slates and sandstones are invariably barren. These facts seem to point to a solution of the Devono-Silurian problem.

VII.—Basic eruptives. A belt of rocks of this type crosses the Tobique just above Blue mountain and continues with remarkable persistence, a short distance to the south of the river, to the summit of Falls mountain on the right hand branch. Rocks of a similar kind also occur to the southward across a great valley in which Bald peak forms a conspicuous centre.

Basic eruptives of a more decomposed and amygdaloidal character are seen on the great hills a few miles to the south and west of the mouth of Neary brook on the right-hand branch. This rock also forms the massive hills at the headwaters of Four Mile and Boover brooks on the Serpentine.

VIII.—Acid Eruptives—A reddish rhyolite is very characteristic ; it forms the whole mass of the Blue mountains and caps many of the hills to east and south of Bald peak. This latter hill is probably of the same nature, but hand specimens show a much darker aspect. These rocks are post-Silurian, possibly post-Devonian in age.

IX.—Pyro-clastic breccia—The whole mass of the Serpentine range is composed of a mottled gray and white rock of clastic origin (?) The brecciated character has been rendered obscure by metamorphism ; awaiting microscopic examination, it seems to be a much altered ash rock with brecciated fragments. The same rock occurs at other places and its associations would point to post-Silurian age. Hand specimens almost exactly resemble some of the ash rocks referred to Huronian age by Ontario geologists.

X.—Agglomerate—Near the mouth of Irving brook on the main Tobique, and at one point on the lower part of the right hand branch a peculiar rock is encountered ; it seems to consist of a basic amygdaloidal eruptive containing rounded fragments of a very similar rock. No conclusions have yet been reached as to the relationships of this example.

It will be seen that an extremely complicated and interesting series of rocks is presented in this region. With one month in the field, and without microscopic sections, the writer has, perhaps, ventured too far in the above notes.

Economic Geology.—The Archæan areas of the Serpentine contain many seams of quartz, but those examined did not look promising. More or less authentic accounts of gold are current among the settlers, and one attempt at mining ended in failure. The only other observations, at all pointing to metallic deposits, were the highly ferruginous character of some of the slates to the eastward of the right hand branch, and a single example of jasper conglomerate in the float near Neary brook.

Work in Charlotte County, N.B.

Mr. Robt. A. A. Johnston.

The early part of the year was occupied in plotting the field-notes of previous years and in assembling information regarding occurrences of meteorites in Canada. Three new meteorites have been reported since the beginning of the present year. Information regarding the finding of these specimens is still incomplete, but it is hoped that this will soon be forthcoming. In other respects, substantial progress has been made with this report.

On the 21st of June, I left Ottawa to resume work in Charlotte county, New Brunswick. A few days were spent in examining a number of localities in the neighbourhood of St. Stephen, about which additional information seemed desirable.

Following this, a survey was made, by means of a Rochon micrometer telescope, of the road from St. Stephen to Brockway, thence by way of Pomeroy Bridge to Little Lake Settlement, and from Pomeroy bridge to the village of St. George. This work was supplemented, as opportunity offered, by examination of various rock outcrops along or near the route travelled. The remainder of the season was employed in investigating the geological and topographical features of the country lying between the Magaguadavic river and the eastern boundry of Charlotte county. This included the measurement of a number of roads, portages and streams, as well as lakes, that had not been previously mapped. In this work I was assisted by Messrs. G. P. O. Fenwick, B. A., and F. E. Bronson. I returned to Ottawa on the 16th of September.

Geological Work in the Northwestern Parts of Nova Scotia.

Mr. Hugh Fletcher.

Mr. Fletcher spent the winter of 1904-05 in the usual work of the office, assisted by Mr. J. A. Robert and A. T. McKinnon.

He left Ottawa on June 7 to continue surveys in Nova Scotia and remained there until January 25, 1906. In the fieldwork he was again assisted during August, September and October by Mr. McKinnon; for three months by Mr. Harold F. Tufte, of Wolfville, and for two months by Mr. James McG. Cruikshanks, who has been with Mr. Faribault for eighteen years, and whose skill and energy were utilized to define the folds of the complicated rocks which underlie the Horton series south of Kentville and Wolfville. With him also from September 18 to the close of the season was Mr. N. D. Daru, of Surat, India.

Mr. McKinnon was engaged in a survey of southern Kings and Annapolis and of northern Lunenburg, a district lying north of the old Dalhousie road, bounded on the east and north by New Ross and Lake George, and on the west by the Halifax and Southwestern railway. Within this district lie large barrens, and the woodlands are intersected by the tote-roads of the Davidson Lumber Company. The eastern part was fully surveyed, while to the westward all available roads connecting large lakes and streams with the main roads were chained. Gray granite is the prevailing rock, but along the southern boundary 'whin' debris appears and 'whin' is perhaps in place at Lake Torment.

In June, Mr. Fletcher made examinations to define more clearly certain geological boundaries on Map-sheets 59 to 62 of Cumberland county, which have been coloured and will be ready for distribution in a few days.

Further surveys were next made along the Kennetcook river to complete Sheets 64, 65, 73 and 74, which are now in the hands of the printer, so that the results of these surveys need not here be adverted to. A white quartzose sandstone from Northfield, near Mr. Jacob Hennigar's, was examined by Mr. Charles Fergie and proved suitable for the manufacture of fire bricks. The strong salt springs and the limestone quarries of the neighborhood have been already mentioned. The manganese mines of Tennycape were

worked last year by Mr. Mortimer Parsons on a lease of ten per cent royalty. The lump ore brings about $100 per ton, while for the finer material it is hard to find a sale. In the neighborhood of Kennetcook Corner and on the Noel road many blocks of pyrolusite lie apparently near the contact of the Carboniferous limestone and Horton rocks, but their source has not yet been uncovered.

Large shipments of gypsum were exported last summer from Wentworth, Walton and other quarries. Samples of limestone from the quarries at Walton and Tennycape were collected by Mr. William Stephens and Mr. Parsons and sent to Dr. Hoffmann for analysis. Quarries of rough sandstone for building have been opened recently at Doddridge and other places on the Midland railway.

Some time was spent in defining more precisely the boundaries of the various geological formations to the westward of Three-mile Plains for Sheets 84, 85, 98 and 103 of Kings and Annapolis counties. These formations comprise Granite, Cambrian, Cambro-Silurian, Silurian, Devonian, Carboniferous Conglomerate and Carboniferous Limestone, described in the Summary Report for 1901, pages 209 to 214, and illustrated by a map. Most of the details of this work, which is still incomplete, are of little immediate interest but will be incorporated with the map. The investigation of the structure of the Horton beds and their relation to the underlying Silurian rocks and to overlying Carboniferous, is of more interest because these Devonian rocks are again being mistaken for coal measures as they were in 1842; conclusions respecting their geological age being again founded on their organic contents. For the reincarnation of this error of more than sixty years ago there seems to be no reasonable justification.

In some of these investigations Mr. Fletcher was aided in September and October by Dr. R. W. Ells and Mr. E. R. Faribault, whose intimate knowledge of the rock formations was of great value in their correlation; he accompanied Dr. Ells to Lepreau and other places in New Brunswick, and at Canterbury and Benton they were fortunate in having the co-operation of Professor L. W. Bailey of the University of New Brunswick who pointed out many features of interest in the structure of the rocks.

The so-called iron mines of Lepreau are on small, irregular, unimportant veins of magnetite in gneissic rocks which have been intermittently exploited for many years. During the last two or three years, under the guidance of a magnetometer, several vertical and slanting boreholes have been drilled to a depth of from 200 to nearly 1,000 feet in an endeavor to locate larger veins of iron ore.

On Sept. 28 in company with Dr. Ells another collection was made of the *Fenestella* of Messenger brook which was sent to Dr. Rudolf Ruedemann, assistant palæontologist of the State of New York, who was greatly interested in the mode of preservation of these fossils. There are, he reports, impressions which look like a *Dictyonema* at first glance, but these are connected by transitional states of preservation with distinct *Fenestellæ*, preserved in relief casts. On closer examination also the completely flattened specimens, looking so much like *Dictyonema*, show features that betray this fenestelloid character, as he thinks. They show regular rows of pores, the dissepiments are much thicker than in *Dictyonema*, as a rule, and so constructed that the lumina of the meshes are oval in form; while in *Dictyonema* they are always rectangular. Besides

the meshes are more regular than in any *Dictyonema* known to him. Some of the lamellibranchs and brachiopods have been reduced to a like black film. Dr. Ruedemann has become a little suspicious by this interesting occurrence as to the graptolite nature of the mineral of *Dictyonema webesteri* which always occurs in similar glazed or much compressed shale and also is reported as differing from other *Dictyonema* by its very regular meshes.

Dr. Ruedeman had previously also made a careful comparison of many specimens of *Dictyonema websteri* with authentical material of *D. retiforme*, from the Niagaran shale in New York, which fails to show any difference sufficient for specific distinction, and he had, therefore, come to the conclusion that *D. websteri* is identical with *D. retiforme*.

Among the fawn-coloured shales underlying the Silurian rocks of Canaan *Dictyonema* has been found in nearly all the brooks, from Harding (Angus) brook below Gaspereau village to Sharpe brook south of Cambridge station. In Duncanson brook thir fossil was collected last summer by Mr. N. D. Daru who also obtained from Elderkinbrook, and other streams in the neighborhood of Kentville and Highbury, smooth and corrugated burrows or trails of annelids of considerable size. In Harding brook, as already stated, *Dictyonema* is associated with a form like *Bryograptus*; near Highbury, with a *Phyllograptus?* discovered by Messrs. Cruickshank and Tufts; and west of the Deep Hollow road near Port Williams, with encrinites. The *Dictyonema* of Sharpe brook was found in abundance above a twenty-feet fall, in several contiguous layers of reddish and gray somewhat sandy shale.

After October 11, some weeks were spent in the neighborhood of Torbrook mines, where work is being vigorously prosecuted by the Londonderry Company, to trace the various bands of diorite and granite and belts of slate and quartzite. This work seems to prove that the rocks lie in several synclines, one of which is crossed in the mine workings, about ninety feet from the Leckie ore-bed, by a tunnel driven south from No. 3 level about 200 feet from the surface near the Woodbury shaft; but ore has not yet been found on the south side of the basin. Down the Woodbury shaft the ore was followed to a vertical depth of about 314 feet; in the main shaft, to 265 feet, and at the Seary shaft to 210 feet, giving a westerly pitch of about 10° to the bottom of the ore-basin. At 162 feet from the ore-bed in the above mentioned tunnel from No. 3 level west, a borehole was drilled 346 feet at an angle of 77°, or at right-angles to the ore in the shaft, and from the same point another hole was drilled 67° for 136 feet, but neither of them cut the ore. Two holes were also bored on No. 5 level, about 310 feet from the surface: No. 1, horizontally or at right-angles to the ore-bed for 192 feet into strata underlying the Leckie bed, and No. 2, in the east end of No. 5 level, for 96 feet running easterly at an angle of 45°. The Nova Scotia Steel Company also expended considerable money last winter in making borings.

In addition to the ore obtained at the Leckie mines, several car-loads were mined in the Bloomington district and shipped at Nictaux station by the Londonderry company, which, having taken an eight months' option of the properties held by Messrs. Brookfield and Corbitt, has put down two new exploratory shafts on the shell ore-bed. One of these is about a mile west of the Woodbury shaft, on the farm of Melbourne Hoffman, and the other about one mile and three-quarters west of the Woodbury shaft,

at Fletcher Wheelocks. From the bottom of both tunnels were driven to the Leckie bed. A line of railway was also surveyed from the Leckie mines to the new shafts.

At the Hoffman shaft, which is 14 by 7 feet and 163 feet deep, a power-house, a lodging house and other buildings have been built. A 60 horse-power return tubular boiler, a hoisting engine and air-compressor have been installed, also a Knowles vertical pump.

The Fletcher Wheelock shaft is of the same size and the equipment about the same as at the Hoffman shaft. After following the ore dipping 77° for 64 feet, it flattened to 54° for about 15 feet, then to 34° for 16 feet, the ore thickening to about 12 feet. The rocks then dip 75° southward as before, but at about 21 feet below the bend the ore pinched out, and at 7 feet farther in the rock the dip changed to the northward at an angle of 75° to 80°. The shaft was continued to a depth of 170 feet, the last 54 feet in rock upon the line of the 75° southward pitch. Both shafts were sunk by Messrs. Patterson and Hyde of Pittsburg, who had previously put down the Allan shafts near Stellarton. To Messrs. Hyde, Parsons and Weir, Mr. Fletcher is indebted for most of the above information and for other kindness.

By request of Mr. A. Johnston, M.P., two visits were made to the Sydney coal field, to inspect explorations carried on by the Dominion Coal Company and others, in search of the Mullins seam, in the neighborhood of Lynk (Hayes) lake and Southwest brook, at the head of Lingan basin. On his second visit, about the middle of January, 1906, Mr. Fletcher accompanied Mr. Patrick Neville, under whose charge these explorations had been made during the preceding summer. The first plan suggested by the engineers of the Dominion Coal Company, to bore with a calyx drill so as to cut all the coals from the Clarke seam downward, had not been carried out; but several pits and bore-holes had been put down near Lynk lake, and a coal seam found on the south side of the lake, which was assumed to be that bored by Burrows near the outlet and subsequently exposed in a shaft nearby, and also to represent, although not actually traced, a seam opened on the southwest brook at or near the horizon of the Martin seam, with which it might thus be identical.

Since the question of the extension of the Mullins seam in this direction has not yet been solved, it is perhaps desirable that borings like those made near Springhill should be undertaken to trace the outcrop from the borehole south of Lynk lake and determine whether that coal runs to the neighbourhood of the Martin seam on Southwest brook, as supposed by Mr. Neville; to trace a coal seam or some well defined rock band from the Routledge pits near the west end of Lynk lake westward or southward around the basin; and also to follow the Tracy seam from Broughton colliery northward towards the fork of the Cowboy and Macpherson roads, to Grand lake and Sydney harbour. It seems possible that a small fault follows the anticline between the Glace Bay and Lingan coal basins, the delineation of which with reference to the submarine workings of Dominion No. 1 colliery seems to warrant the expenditure necessary; and in any case it is important to determine the position and nature of the anticline which must affect the submarine workings of that and other collieries. The surface does not seem to be deep, clay-shales and other rocks being found at no great depth, consequently these explorations should not cost much in comparison with the advantage of having once for all defined the structure of this part of the coalfield.

Boring was continued by the Standard Coal Company in Cumberland county and the same tools and derrick with which the borehole was put down at Pettigrew were used for a second hole on the shore of Fullerton lake about 275 yards south of the saw-mill at Newville station. Drilling was begun in a mixture of red clay or mud and very fine sand of the consistency of slime, resting at 87 feet upon bedrock covered by great blocks among which the casing collapsed at 75 feet. This hole was accordingly abandoned and the drill moved to higher land a short distance northeast of Newville station where a hole was begun which has now reached a depth of about 900 feet and is still in conglomerate. At 808 feet the bit was lost by a break in a welding and drilling had to be suspended until fishing-tools were obtained from Pennsylvania by which it was recovered.

The Rear brook borehole was carried to a depth of nearly 3,100 feet without, however, reaching the bottom of the conglomerate which includes layers of reddish or purplish argillaceous shale and sandstone. Much of the debris resembles Millstone grit but is apparently derived from a conglomerate like that of New Glasgow bridge in which there are many large pebbles of this rock.

Mr. Isaac McNaughton's borehole north of Trenton was continued to a depth of about 700 feet in strata similar to those found higher.

Gold Fields of Nova Scotia.

Mr. E. Rodolphe Faribault.

Mr. Faribault was engaged in office work at Ottawa from October 6, 1904, until June 20, 1905, when he left for field work in Nova Scotia and returned to Ottawa on October 14, 1905.

The greater part of the time passed in the office was spent in plotting surveys, made the previous summer by him, and in revising the plotting of surveys, made by his assistants, of the gold mining districts of Leipsigate, Malaga and Brookfield and the country surrounding them, in the counties of Lunenburg and Queens, as detailed in the Summary Report for 1904, pages 320 to 332.

Special plans of the gold mining districts of Leipsigate, Malaga, Brookfield and Clam Harbour were also compiled on the scale of 250 feet to one inch, and these plans with that of Miller lake surveyed in 1903, are now completed and only require to be traced for publication.

The large scale plan of the gold mining district of Harrigan Cove, surveyed in 1901 and reported on in the Summary Report for that year, page 416 to 419, is now being engraved.

Good progress was especially made this year in the compilation of the one-mile to an inch map from the surveys executed for several years past in the counties of Halifax, Hants and Lunenburg. The greater part of this compilation was made by Major F.

O'Farrell, who joined this department on October 24, 1904, and has since then been continuously engaged in carrying out this work, which has been so long in arrears. The area compiled extends along the Atlantic shore from the head of St. Margaret bay to Mahone bay, and as far north in the interior as Mount Uniacke, Newport and Windsor, and includes all the rivers flowing south into St. Margaret bay and Mahone bay, and the Ponhook lake and St. Crois river flowing north into Minas basin. This region is covered by the map sheets of Windsor, Ponhook lake, St. Margaret bay, Aspotogan and Mahone bay, each measuring 18 inches long by 12 inches wide. It is estimated that with the assistance now received in a little over one year the office work will have caught up to the field work.

Much of Mr. Faribault's time was taken up in correspondence, especially in answering letters from persons seeking information and advice on the gold fields of Nova Scotia, which are attracting much attention at the present time in connexion with deeper mining.

Advice and reports have also been given, by special request, to the Government of Nova Scotia regarding the advisability of extending government assistance to certain companies in the sinking of deep shafts in certain gold mining districts, for which the provincial legislature passed an Act at its session of 1903, offering to bear half the expense of the actual sinking from the surface to a vertical depth not exceeding 2,000 feet.

On the field work accomplished in the Nova Scotian gold fields during the summer of 1905, Mr. Faribault reports as follows :—

In accordance with your instructions, I left Ottawa with Major O'Farrell on June 20, 1905, for Elmsdale, Nova Scotia, where I was joined by my field assistants, Messrs. J. McG. Cruickshank and A. Cameron, who have now been with me for nineteen and eighteen years respectively. Major O'Farrell continued under my supervision the compilation of the manuscript map, while my other two assistants were engaged in field work the whole season, until the end of October.

The greater part of my time was devoted to the revising of the geological structure of the gold-bearing rocks to the east and north of Halifax, included in the map sheets of Lawrencetown, Musquodoboit harbour, Gays river, Renfrew and Windsor, as well as the northern part of the Waverly sheet, in order to complete and have them ready for publication. The surveys of that region were made several years ago, but owing to pressure of office work were compiled only recently. In this work I was ably assisted the whole season by Mr. Cruickshank and the latter part of the season by Mr. Cameron, both of whom were entrusted with the revision of the topography in order to bring it up to date. The surveys were plotted and transferred immediately to the manuscript map from week to week as the work progressed, and this method proved very satisfactory for working out the structure with more accuracy and detail.

This region is for the most part underlaid by the slates and quartzites of the gold-bearing rocks. Towards the east and west these rocks are replaced by granite, which also forms a small isolated patch to the southwest of Wellington station. The gypsum and limestone of the Lower Carboniferous are predominant about Windsor and Newport.

where gypsum quarries are extensively worked, and they form irregular basins along the valleys of the Shubenacadie, Nine Mile, Gay and Musquodoboit rivers, where quarries of limestone, gypsum and selenite have also been worked on a small scale, and deposits of bog iron ore have been prospected recently.

In the gold bearing area examined are included the gold mining districts of Lake Catcha, Lawrencetown, Oldham, Renfrew, Mount Uniacke, and South Uniacke, detailed plans of which have been published on a large scale; also those of Cow Bay, Rawdon, East Rawdon, Ardoise, Meander River and the celebrated antimony-gold mines of West Gore. Most of these were at one time or another the centres of important mining operations, but with the exception of West Gore, Oldham and Mount Uniacke which are still producing, they are now for the most part inactive.

Since my return to the office, the Lawrencetown, Musquodoboit Harbour and Gay River map-sheets were completed and they are now being published; while those of Elmsdale, Windsor and Ponhook will be ready for publication in the spring, before field work is resumed. It is intended, next summer, to push vigorously the revision of the Waverley, Halifax, Prospect, Ashpotogan and St. Margaret Bay sheets, in order to have them completed by the end of the year.

Progress was also made in the general survey of the western counties, by Mr. Cameron during the first three months of the season. He completed the odometer survey of all the roads in Queen's county and began those in the southeastern part of Annapolis county. He also surveyed the headwaters of Lahave river, as far north as the old Dalhousie road and west to the line of the Halifax and Southwestern railway.

The Nova Scotia government engaged last summer Mr. T. A. Rickard, mining engineer, to report on the gold fields of the province and the possibility of developing them successfully on a larger scale and to greater depth. At the request of the provincial government and with the authorization of Dr. Bell, I spent three weeks in August, with Mr. Rickard, making a general examination of the most important gold mining districts. The following districts were visited: Montague, Waverley, Oldham, Renfrew, Mount Uniacke, Caribou, Dufferin, Harrigan Cove, Goldenville, Cochran Hill, Country Harbour, Isaac's Harbour. Seal Harbour, Forest Hill, West Gore, Leipsigate and Brookfield. Valuable information and data have thus been collected and many interesting photographs taken which will be useful in bringing up to date my final report, now in preparation, on the gold fields of the province.

CHEMISTRY AND MINERALOGY.

Dr. G. C. Hoffmann.

In reporting on the work done in these branches of the Survey's operations, Dr. Hoffmann says :—

"The work carried out in the chemical laboratory has been upon the usual lines, that is to say, it has been almost exclusively confined to the examination and analysis of such ores and minerals, etc., etc., as were deemed likely to prove of economic value and importance. Briefly summarized it embraced :

"1. Analyses of different varities of fossil fuel from various parts of the Dominion, namely of—Lignite, from a deposit in Tp. 63, on or near Towtinow river, some eighteen miles south-southwest of Athabaska landing, Alberta. Lignitic coal from tunnel on the Jackson seam on Quilchena creek, five miles from its entry into Nicola lake, Yale district, B.C. Coal from a five-foot seam at the head of Snow creek, between Panther and Red Deer rivers, Alberta, from a seam on the east fork of Pine river south, also from a seam on Cañon creek, Pine river south, and from a seam on Coal brook, Pine river south, Cariboo district, B.C. ; from outcrops near the junction of the Coldwater and Nicola rivers, Yale district, B.C. ; anthracite coal from the Costigan seam and underlying seams, Panther river, Alberta, and from Sheep creek, Alberta ; semi-anthracite from the same Costigan seam, and from the lower seam on Goat river, Telqua river, Bulkley river, Cassiar district, B.C.

2. Analyses, more or less complete, of several varieties of iron ore, namely, of magnetite, from the property of W. R. Neily, close to the Leckie mine, Torbrook mines, Annapolis county, N.S. ; from a point three miles west of Clarendon station, parish of Clarendon, Charlotte county, N.B. ; from a point on the Rivière des Quinze (Ottawa river), Pontiac county, Que. ; from the northwest branch of the Gatineau river, Que. ; from the vicinity of Lake Temagami, Nipissing district, Ont. Hematite, from the property of John F. Yeats, on lot 6, range 1, Durham township, Missisquoi county, Que. ; and from the property of Levi J. Blake, Pinnacle mountain, Missisquoi county, Que. Clay iron-stone, from sections six and seven, of township 10, range xxi, west of the fourth initial meridian, Alberta.

3. Analyses, partial, of copper ore from a shaft sunk in the Triassic trap at Wellport, Digby county, N.S. ; La Tête, Charlotte county, N.B. ; Orford township, Sherbrooke county, Que. ; the north-half of lot 3, concession iv, Kent township, Nipissing district, Ont. ; mining location No. 2961, range 455, northeast of Schreiber, Thunder Bay district, Ont ; and from the Europa claim No. 14, Britannia mountain, Howe sound, B.C.

4. Analyses, more or less complete, of limestones and dolomites (being a continuation of the series of analyses of such stones already carried out in connexion with an

inquiry into their individual merits for structural purposes, for the manufacture of lime, or of hydraulic cement, or for metallurgical purposes, &c.), including limestone from three miles east of Brookfield, Colchester county, N.S.; from Dewars Hill, west side of Pugwash harbour, Cumberland county, N.S.; from near Lake Mercier, Labelle county, Que.; from the quarry of Mr. Beaulieu, on Little Mascouche road, Ste. Anne des Plaines parish, Terrebonne county, Que.; from lot 5, and range iv, Grenville township, Argenteuil county, Que.; from Rudd's quarry, Barriefield, Pittsburgh township, Frontenac county, Ont.; and from Peterborough township, Peterborough county, Ont. Dolomite, from lots 1 and 4, range v, Wentworth township, Argenteuil county, Que. and from near Lake Mercier, Labelle county, Que.

5. The examination, in many instances accompanied by a more or less complete analysis, of samples of clay, from numerous localities, in regard to their suitability for the manufacture of bricks, tiles, sewer-pipes, terra-cotta, stone-ware, &c., the localities including the vicinity of Baddeck, Victoria county, N.S.; material from the farm of Angus McLean, French Vale, Cape Breton county, N.S.; clays from Cumberland county, N.S.; from a boring two miles east of 'The Brook' village, Clarence township, Russell county, Ont.; from a boring, lot 10, concession iii, Sarawak township, Grey county, Ont.; from an extensive deposit on section 28, township xii, range xxiv, west of the second initial meredian, Saskatchewan; from the homestead of Mr. A. M. Kay, on the northeast quarter of section 34, township xxxii, range 1, west of the fifth initial meridian, Alberta; from a bed on the north-half of section 11, township xxix, range xxiii, west of the fourth initial meridian, Alberta; from Kildonan, near Winnipeg; from the west half of section 19, township vii, range iii, west of the fifth initial meridian, Alberta; from Prairie creek, Clearwater river, Alberta; and from the mountain three miles east of Enderby, Yale district, B.C.

6. Analyses of natural waters carried out with the object of ascertaining the suitability of the same for domestic or manufacturing purposes, or probable value as a remedial agent, from, respectively, a boring at Rear brook, East River, Pictou county, N.S.; from the mine of the Souris Coal Mining Company, Souris district, Saskatchewan; from a spring near Bakers or Carrington lake, on the east side of Moose mountain, Saskatchewan; from wells at Whitewood and Ingram, Saskatchewan; from a well on the property of Mr. Archibald, on section 30, township liii, range xxiii, west of the fourth initial meridian, Alberta; and from a spring on the bank of Shuswap river, about eight miles north of Enderby, Yale district, B.C.

7. Miscellaneous examinations. These include the examination, accompanied in most instances by a partial analysis, of specimens of:—Argillaceous shale, bitumen, bituminous shale, bog iron-ore, carbonaceous shale, deposits from springs, ferruginous shale, graphite, graphitic-schist, iron-ochre, manganese ore, marl, molybdenite, pyrophyllite, pyroschist, silt and talc-schist.

A very careful examination has also been made of a sample of the sand in the final washing of the material obtained in dredging for gold in the Fraser river, two miles below Lillooet. This sand, it was found, contained, in addition to flattened grains of native gold, scales of native platinum, and grains of iridosmine, also some small grains of a native iron-nickel alloy, to which the name 'souesite' has since been given

by the writer, having, in the pure condition, the following composition :—Nickel 76·48, iron 22·30, copper 1·22 = 100·00. Should this material be obtainable in any quantity, it would, it need scarcely be said, be valuable as a source of nickel.

During the period covered by this report, 628 mineral specimens were received for identification or for the purpose of eliciting information in regard to their economic value. Very many of these were brought by visitors, and the information sought in regard to them was not infrequently communicated to them at the time of calling. In other instances—those where a more than mere cursory examination was called for, or when a partial or even complete analysis was deemed desirable—the results were, as in the case of those specimens which had been sent from a distance, communicated by mail. The correspondence in this connexion called for the personal writing of 327 letters, many of which constituted lengthy reports ; whilst the number of letter received; in the same connexion, amounted to 110.

'The successful carrying out of the work above outlined, is, I have much pleasure in acknowledging, in no small measure due to the assiduity and zeal displayed by assistant chemist and mineralogist, F. G. Wait, who has at all times manifested great interest in the work of the laboratory.

'The additions to the mineralogical and lithological section of the Museum during the past year, embraced :—

A.—Duplicates of Specimens which were sent to the Laboratory for Examination.

Clay, from a deposit on section 28, township xii, range xxiv, west of the second inital meridian Saskatchewan.

Clay iron-stone, from sections 6 and 17, township x, range xxi, west of the fourth initial meridian, Alberta.

Hematite, from lot 6, range i, Durham township, Missisquoi county, Que.

Molybdenite, in foliated masses, distributed through a gangue composed of quartz, feldspar, and a little hornblende, from lot 6, range xii, Eardley township, Wright county, Que.

Molybdenite, fine-granular massive, in a matrix of quartz, from one of the Tamarac group of claims on Gnawed mountain, Yale district, B.C.

Talc, from lot 683, in No. 2 Craig's Road Range, Ireland township, Megantic county, Que.

B.—Collected by Members of the Staff engaged in Field-work in connexion with the Survey.

Barlow, Dr. A. E. :—

Twenty specimens, consisting of smaltite, niccolite, and silver-bearing ores, from various mines and prospects in the cobalt-nickel-silver mining area, Coleman township, Nipissing district, Ont.

Ingall, E. D., all from Coleman township, Nipissing district, Ont. :—

(*a*.) A specimen of disseminated native bismuth from the Timiskaming and Hudson Bay Mining Company's mine, on lot 7, concession 5.

(*b.*) A specimen of erythrite from the Savage mine, near the southern end of Carl lake.

(*c.*) A specimen of a leafy form of native silver in the matrix, from the Trethewey mine, location J. B. Y.

Johnston, R. A. A. :—

Two specimens of an incrustation of radiating fibrous malachite from the Seattle claim, Iron mountain, Yale district, B.C.

Low, A. P. :—

Crystals of pyroxene found, as a secondary mineral, in a soft, light green weathering, green chloritic-schist resulting from the alteration of diabase occurring on Chibougamau river, six miles below the junction of Brock river, in the northern part of Quebec.

McConnell, R. G., B.A. :—

(*a.*) A nugget of native copper from Burwash creek, Kluane river, a stream flowing out of the northern end of Lake Kluane, Yukon Territory.

(*b.*) Pellets of native silver from the same locality as the preceding.

Parks, Professor W. A. :—

All from Coleman township, Nipissing district, Ont.

(*a.*) Six specimens of native silver, eleven specimens of niccolite with native silver, and three specimens of smaltite, from the La Rose mine.

(*b.*) Fifteen specimens of smaltite, nine specimens of smaltite with erythrite, two specimens of native silver, three specimens of smaltite with native silver and two specimens of niccolite with native silver, from the Ferland and Chambers mine.

(*c.*) One specimen of smaltite with native silver from the McKinley and Darragh mine.

Poole, R. S., M.A. :—

The following specimens from Vancouver island : A specimen of coal coked by andesite, Brown river, Comox ; a specimen of coal coked by andesite, Cumberland ; a specimen of lower shale, near contact, Nanaimo river ; an association of coal and andesite from outlet of Comox lake ; a specimen of floor rock, trap, and shale with attached coal ; two nodules of coal from lower seam near Protection island shaft.

Willimott, C. W. :—

A crystal group of nephelite from lot 25, concession 14, Dungannon township, Hastings county, Ont.

(C.—By presentation.)

Bèlanger, Joseph :—

A specimen of auriferous quartz from a vein about three miles north—northeast of Michipicoten Mission, north shore of Lake Superior, Thunder Bay district, Ont.

Boisvert, Alex., per Dr. H. M. Ami, (Survey) :—

A sample of shell marl from a deposit covering fifteen acres and having an average thickness of three feet—in part on lot 2 and in part on lot 3, of range vii Bouchette township, Wright county, Que.

Charest, A. :—

Concretionary nodules found on the shore of a small unnamed lake a few miles northeast of Lake Kiemawist, Abitibi district, Que.

Plant, James E., of Charlottetown, Prince Edward Island :—

A fragment of a massive, radiating, fibrous limonite from Grindstone island, one of the Magdalen group, Gulf of St. Lawrence.

Latchford, Hon. Frank R. :—

(a) A specimen of erythrite, a specimen of an intimate mixture of smaltite and cobaltite with a little native silver and a specimen of smaltite with some cobaltite from the vicinity of Cobalt, Ont.

(b) Model of the Proton meteorite, found near Proton station, Grey county, Ont.

Morrison, Thos., of Bancroft, Ont. :—

A specimen of sodalite with hydronephelite, from lot 25, concession 14, Dungannon township, Hastings county, Ont.

Morrison, William :—

Two samples of clay, one from a bed on lot 10, and the other from a bed which is partly on lot 10 and partly on lot 11, of concession 3, Sarawak township, Grey county, Ont.

Nattress, Rev. Thomas, per Dr. J. F. Whiteaves (Survey) :—

A fragment of a nodule of grayish-white to white, opaque, dull, chert or hornstone, found in a brownish-gray fossiliferous dolomite met with in cutting a channel in the bed of the Detroit river at Amherstburg, Malden township, Essex county, Ont.

Soues, F., Gold Commissioner, Clinton, B.C. :—

(a) A specimen of stibnite from a quartz vein at the southeast end of Chilco lake, New Westminster district, B.C.

(b) A sample of sand obtained in dredging for gold in the Fraser, near Lillooet, B.C.

Winning, P. B., per Mr. R. L. Broadbent :—

Specimens of black spinel, in the matrix, from lot 52, range 2, Bigelow, Labelle county, Que.

(D.—By Purchase.)

Through Dr. Robert Bell :—Seven specimens of rich native silver-bearing ores' from the Trethewey silver cobalt mine, Coleman tp., Nipissing dist., Ont.

Through Dr. A. E. Barlow :—Two nuggets of silver from the New Ontario mine, location J.B.Y., east side of Sasaginaga lake ; and a nodular mass of native silver-bearing ore, weighing two hundred and fifty-seven pounds, and containing, approximately, twenty per cent of native silver, from the La Rose mine, Cobalt, Ont.

Mr. C. W. Willimott has devoted considerable time to the making up of collections of minerals and rocks for various Canadian educational institutions. The following is a list of those to which such collections have been sent :—

		Specimens.
1. Public School, Cornwall, Ont., consisting of..		75
2. Summer School of Science, Kensington, P.E.I., consisting of		75
3. Public School, Shelburne, Ont.	"	75
4. Winter Street School, St. John, N.B.	"	75
5. Albert Street School, St. John, N.B.	"	75
6. County Academy, Port Hood, Inverness county, N.S.	"	100
7. Graded School, Norton, N.B.	"	75
8. High School, Forest, Ont.	"	75
9. Public School, East Toronto, Ont.	"	75
10. High School, Gravenhurst, Ont.	"	100
11. Public School Board, Dunnville, Ont.	"	100
12. High School, Kincardine, Ont.	"	100
13. Superior School, North Head, Grand Manan, N.B.	"	100
14. Sapperton School, Sapperton, B.C.	"	75
15. High School, Thorold, Ont.	"	100
16. Academy, Inverness, Que.	"	100
17. High School, Simcoe, Ont.	"	100
18. Model School, Athens, Ont.	"	100
19. Public School, Palmerston, Ont.	"	75
20. High School, Cornwall, Ont.	"	100
21. St. Joseph's Academy, St. Hyacinthe, Que.	"	75
22. High School, Nanaimo, B.C.	"	100
23. Collegiate Institute, St. Marys, Ont.	"	100
24. High School, Athens, Ont.	"	100
25. Public School, Chatsworth, Ont.	"	30
26. High School, Glencoe, Ont.	"	100
27. St. Bernard College, Sorel, Que.	"	100
28. Sisters of the Congregation of Notre Dame, Quebec	"	75
29. High School, Niagara-on-the-Lake, Ont.	"	100
30. High School, Walkerton, Ont.	"	100
31. Natural History Association, Chatham, N.B.	"	100
32. High School, Welland, Ont.	"	100
33. Model School, St. Thomas, Ont.	"	100
34. Macdonald's Consolidated School, Kingston, N.B.	"	100
35. Public School, Pointe aux Trembles, Que.	"	100
36. High School, Sterling, Ont.	"	100
37. London Historical Society, London, Ont.	"	82
38. High School, East Toronto, Ont.	"	100
39. St. Jean l'Evangeliste Acadamie, Point St. Charles, Que.	"	75
40. High School, Almonte, Ont.	"	100
41. St. Vincent de Paul, Brockville, Ont.	"	75
42. Douglas Avenue School, St. John, N.B.	"	75
43. Convent Jesus Marie, Beauceville, Que.	"	75
44. Jameson Avenue Collegiate Institute, Toronto, Ont.	"	100
45. Young Men's Christian Assn., Charlottetown, P.E.I.	"	100
46. Dept. of Mineralogy, University of Toronto, Toronto, Ont.	consisting of..	5

In addition to which, collections have also been made up and forwarded to the :—

	Specimens.
Canadian Commercial Agent in Paris, France, consisting of	62
Exhibition Branch of the Department of Agriculture, Ottawa, consisting of	12
University of Virginia, Charlotteville, Va., U.S.A., consisting of	6

Making in all a total of 4,097 specimens of minerals thus distributed.

Mr. Willimott also visited a number of mineral localities, during the summer months, for the purpose of collecting further material for the making up of collections of the nature of those above referred to. While so engaged he procured several hundred-

weight of each of the following :—Calcite ; chrome garnet in the matrix ; diopside ; hematite ; magnesite ; pyrite ; pyrrhotite ; and serpentine. Also numerous specimens of limestone, dolomite, and serpentine, suitable for use as a marble. These latter he will cut and polish and, later on, report upon in regard to their relative merits for decorative purposes.

PALÆONTOLOGY AND ZOOLOGY.

Dr. J. F. Whiteaves.

Dr. Whiteaves reports that the manuscript of the fourth and concluding part of Palæozoic Fossils, Vol. III., which was commenced last year, has been completed, and an index to the whole volume has been prepared. This part of the volume consists of four papers, as follows :—

(1) 'The Fossils of the Silurian (Upper Silurian) rocks of Keewatin, Manitoba ; the northeastern shore of Lake Winnipeg and the lower part of the Saskatchewan river.'

(2) 'The Canadian species of *Plectoceras* and *Barrandeoceras.*

(3) 'Illustrations of seven species of fossils from the Cambrian, Cambro-Silurian, Silurian and Devonian rocks of Canada.'

(4) 'Revision of the nomenclature of the fossils of the Guelph formation of Ontario.

One-half of the first of these papers and the whole of the second and fourth were written in 1905, the third being little more than a reprint of previously published, but not illustrated, descriptions. The part, as a whole, is to be illustrated with eighteen full-page plates and eight text figures, the drawings for which are now being reproduced. As soon as proofs of these reproductions are received, the explanations of the plates can be written and the letter press sent to the printer.

Two small collections of Cambro-Silurian fossils from Ontario, viz., one from Kingston Mills and one from Campbellford, and two from the Vancouver Cretaceous, have been examined and reported on. Information about Canadian fossils, or zoological specimens, has also been, as usual, given or sent to various applicants.

In the department of zoology, small collections of land and fresh water shells, made in 1905 at various localities in Keewatin, Quebec, Ontario and British Columbia, have been named for W. McInnes, O. O'Sullivan, A. P. Low, Prof. Macoun, and J. M. Macoun. And, in this connexion, the whole of the recent Canadian *Cycladidæ* in the Museum of the Survey has been sent, in instalments, to Dr. V. Sterki, of New Philadelphia, Ohio, who has made a special study of this difficult group of fresh-water bivalves. These specimens have been kindly and gratuitously determined by Dr. Sterki, who recognizes twenty species of *Sphærium* and eighteen of *Pisidium* (or *Corneocyclas*), or more than double the number that were previously known as occurring in Canadian waters.

At the request of Dr. H. Kluge, nearly the whole of the recent *Bryozoa* from the Atlantic and Pacific coasts of Canada, in the Museum of the Survey, have been sent to Berlin for further study and comparison.

Six short papers on Canadian zoological subjects have been written in 1905, and published in various scientific journals. Four of these papers are lists of the species represented in small collections of land and fresh-water shells from Keewatin, Yukon, and several other widely distant localities. The fifth is an illustrated description of a new *Gomobasis* (a fresh-water shell) from Upper Columbia lake, B.C., collected by Mr. J. B. Tyrrell in 1883; and the sixth records the capture of a specimen of the Banded Pocket-mouse (*Perognathus fuscus*) in Manitoba. A bibliography of Canadian Zoology for 1894, exclusive of entomology, has been prepared and has been printed in the Transactions of the Royal Society of Canada for 1905.

During Dr. Bell's absence from Ottawa, for a little over two months last summer, the duties of Acting Deputy Head and Director were performed by the writer. In addition to letters written or dictated in that capacity, the writer's official correspondence in 1905 consisted of 194 letters received and 168 written.

The following specimens were received in 1905, either from members of the staff or from employees of the department:—

Professor Macoun :—

A collection of fresh water shells from the St. Lawrence river near Quebec, and of marine shells and sponges from Cap à l'Aigle, Charlevoix county, Que.

Fletcher, Hugh :—

Several specimens of *Dictyonema* from brooks south and east of Kentville, Kings county, and from Spinney brook, Annapolis county, N.S.; also some shales with plant stems from the latter place.

Ells, Dr. R. W.:—

A few fine specimens of marine shells from the Queen Charlotte islands.

McConnell, R. G.:—

Manotis suborbicularis and two other fossils from Cañon Burwash creek, Kluane district, Yukon territory.

Low, A. P.:—

Small collection of fresh-water shells from northern Quebec.

Ami, Dr. H. M.:—

About 400 fossils from the Trenton limestone at the Montmorency river, P.Q., and 150 from the marine Pleistocene clays at Besserers, Ont. Large collections of Silurian and Devonian fossils from St. Helens island, Montreal, made for Dr. Ami by Mr. Edward Ardley.

Lambe, L. M.:—

Large collections of fossils from the Lower Helderberg rocks at Cap Bon Ami, N.B.; also a few fossils from rocks of the same age behind Point Fleurant, P.Q., and from Black Cape, about three miles east of the Cascapedia river, Que.

A few specimens of fossil fishes from the Lower Devonian rocks at Campbellton, N.B., and a large collection of fossil fishes and plants from the Upper Devonian rocks near West Maguacha, Scaumenac bay, P.Q. Some recent marine sponges, a few land shells and a small specimen of *Plethodon cinereus* from West Maguacha.

McInnes, W.:—

A collection of fresh-water shells from various localities in Keewatin and northern Ontario.

Macoun, J. M.:—

Collection of fresh-water shells from southern British Columbia.

Macoun, J. M. (per W. Spreadborough):—

152 skins of mammals, 249 of birds, sets of eggs of thirteen species of birds and a collection of land and fresh-water shells, from southern British Columbia.

Dowling, D. B.:—

Twenty-five fossils from quartzites of the Carboniferous and twenty from the Carboniferous limestones of the Elk Range, Rocky mountains. Two fragments of spear and arrow head from the Kananaskis river, Alberta.

Keele, Joseph :—

Nine fossils from the Upper Stewart river, Yukon Territory.

O'Sullivan, O.:—

Two marine sponges from Kettle river, south coast of Hudson bay, and specimens of twelve species of fresh-water shells from Knee lake, Keewatin.

Poole, H. S.:—

Collection of fossil plants, *mollusca and crustacea*, from the Cretaceous rocks at various localities on Vancouver island, but mostly from Nanaimo and Comox.

Cairnes, D. D.:—

A large collection of fossil plants, shells, &c., from the Cretaceous rocks of the Foothills of the Rocky mountains, south of the main line of the C.P.R.

The additions to the palæontological, zoological, archæological and ethnological collections in the Museum during 1905, and from other sources, are as follows.

By presentation :—

(*A.—Palæontology.*)

Springer, Hon. Frank, East Las Vegas, New Mexico :—

Six fine specimens of fossil crinoids, one from the Devonian rocks of Michigan, and five from the Lower Carboniferous rocks of Iowa and Indiana.

Grant, Colonel C. C., Hamilton, Ont. :—

Eight fossils from the Cambro-Silurian drift at Winona, and thirty-four from the Niagara formation at Hamilton and Grimsby, Ont.

Johnston, W. A., Athens, Ont. :—

Two good specimens and fourteen fragments of *Nanno Kingstonensis*, from Kingston Mills, Ont.

Narraway, J. E., Ottawa :—

Specimen of *Tripteroceras xiphias*, from the Black River formation near Ottawa.

Wilkins, F. W., Norwood, Ont. :—

Vertebra of dinosaur, and two other fossils, from the Belly River formation near the Battle river, Alberta.

Topley, H. N., Ottawa :—

Vertebra of *titanothere* from the Cypress hills; and two specimens of *Cyprina ovata* and one of *Baculites ovatus*, from the Cretaceous rocks thirty-five miles southeast of Irvine, Alta.

(*B.—Zoology.*)

Latchford, Hon. F. W., Ottawa :—

Seven specimens of *Unio radiatus* from the Ottawa river at Britannia; three of *Unio luteolus*, young, from the Rideau canal at Ottawa; and two of *Anodonta subcylindracea* from St. Justine, Vaudreuil county, Que.

Lambart, Hon. O. H., Ottawa :—

Flying Squirrel (*Sciuropterus volucella*) from New Edinburgh, Ottawa.

Criddle, Norman, Aweme, Manitoba :—

Mounted specimen of the Banded Pocket-mouse (*Perognathus fasciatus*) from Aweme.

Smith, John, Ottawa :—

Penis bone of seal from Ungava bay, brought some years ago by the late G. S. McTavish, of the Hudson's Bay Co. Drilled at one end and slightly carved, possibly by Eskimo.

Henderson, F. D., Ottawa :—

Skull of American bison from the province of Saskatchewan.

Dignan, Hubert, London, Ont. :—

A small living soft-shelled turtle from the waterworks at London.

Eifrig, Rev. C. W. G., Ottawa :—

Specimens of two species of *Sphærium*, from the Liévre river at High Rock, Que.

Holmes, M., Cantley, Que.:—

Star-nosed mole in the flesh, from Cantley, Wright county, Que.

Beaupre, E., Kingston, Ont. :—

Three photographs of the nest and eggs of Canadian birds.

(*C.—Archæology and Ethnology.*)

Forbes, W., Ottawa :—

Three arrow-heads, three stone adzes or skin-scrapers, and a piece of weathered rock, resembling a skin-scraper, from Cameron island, three miles from Stanley island, St. Lawrence river.

McDougall, David, Morley, Alberta, per D. B. Dowling :—

One obsidian spear head, from Morley.

Stewart, James, Grande Prairie, B. C.:—

One stone pestle, from Grande Prairie.

Vertebrate Paleontology.

Mr. Lawrence M. Lambe, (Vertebrate Palæontologist).

With the exception of part of the summer, devoted to field-work, Mr. Lambe's time during the past year has been mainly occupied in the study of the vertebrate fauna of the Oligocene deposits of the Cypress hills, Assiniboia, as represented by his collection of 1904, of which a provisional list of the contained species was given in last year's Summary. The report on the Oligocene fauna, to form part IV of volume III (quarto) of contributions to Canadian Palæontology, is fairly under way, a considerable part of the manuscript is ready, as are also a number of drawings for the plates. In anticipation of the appearance of this memoir some of the species that proved to be new to science (or of particular interest) and that it was thought advisable to describe without delay, form the subject of the following illustrated papers published during the year :—

'On the tooth-structure of *mesohippus westoni* (Cope),' American Journal of Science.

'Fossil horses of the Oligocene of the Cypress hills, Assiniboia,' Transactions Royal Society of Canada.

'A new species of Hyracodon (*H. priscidens*) from the Oligocene of the Cypress hills,' Transactions Royal Society of Canada.

Reprints of these papers have already been distributed.

The month of July and half of August was spent in the field, principally at West Maguacha, Chaleur Bay where upper Devonian rocks yielding a rich fish fauna are exposed. Here a large collection of both fish and plant remains was made to supplement those already in the possession of the Survey. This new material, when studied, is expected to add considerably to our present knowledge of the later Devonian fauna as represented in these beds. The lower Devonian rocks at Campbellton, N.B., were also visited and a small collection of vertebrate remains made therefrom. Advantage was taken of close proximity to the Lower Helderberg rocks near Little Cascapedia, Que and at Cap Bon Ami, N. B. to add to the collections of invertebrate fossils from these localities. The collection made at Cap Bon Ami is a large and representative one and should prove an important accession to the material previously secured from this place.

Although apart from vertebrate palæontology, a short time was given to a report on fossil corals obtained by Mr. A. P. Low, at Beechey island, Southampton island and Cape Chidley, during his expedition of 1903-4 to Hudson bay and Arctic islands. This report is incorporated in Mr. Low's report as an appendix.

A large cup-shaped monaxonid sponge obtained by purchase from Mr. F. Landsberg, of Victoria, B.C., during the early part of the year was described and figured in a paper entitled 'A new recent marine sponge (*Esperella bellabellensis*) from the Pacific coast of Canada.' This paper was published in the Ottawa Naturalist and reprints of it have been distributed.

Early in the year a number of excellent casts of types (or original fossils), and photographs of mounted skeletons and restorations of Tertiary vertebrates, principally from the Eocene and Miocene formations of the western States, was purchased from the American Museum of Natural History, New York. The types and photographs of skeletons are for use in studying the mammalian faunas of the Tertiary rocks, as represented by our own collections from the west. and are available, with the photographs of restorations, as an extremely interesting addition to the museum for exhibition purposes.

The casts of types or original fossils are of :—

Heptodon calciculus, Cope. Palate and lower jaws. Eocene.
Colodon dakotensis, Osborn and Wortman. Upper jaws. Oligocene.
Sytemodon primævus, Wortman. Palate and lower jaw. Eocene.
Protapirus validus, Hatcher. Skull. Oligocene.
Oreodon culbertsoni, Leidy. Fore and hind foot. Oligocene.
Hyænodon horridus, Leidy. Fore and hind foot. Oligocene.

Series of fossil horse feet and skulls illustrating the evolution of the horse :—

Hyracotherium craspedotum. Fore and hind feet. Eocene.
Mesohippus bairdi. Fore and hind feet. Oligocene.
Mesohippus copei. Hind foot. Oligocene.
Neohipparion whitneyi. Fore and hind feet. Miocene.
Protorohippus venicolus. Crushed skull and jaws. Eocene.
Mesohippus bairdi. Skull and jaws. Oligocene.
Hypohippus equinus. Skull and jaws. Miocene.
Merychippus sejunctus. Skull and jaws. Miocene.

Series of fossil camel feet illustrating the evolution of the camels and llamas :—

Protylopus petersoni. Hind limb. Eocene.
Poëbrotherium wilsoni. Fore and hind feet. Oligocene.
Protolabis montanus. Fore and hind feet. Miocene.
Alticamelus altus. Hind limb. Miocene.
Protoceras celer, Marsh. Fore and hind feet. Oligocene.
Equus complicatus, Leidy. Upper molar. Pleistocene.
Equus occidentalis, Leidy. Upper molars. Pleistocene.
Equus pectinatus, Cope. Upper molars. Pleistocene.
Equus excelsus, Leidy. Upper jaw. Pleistocene.
Neohipparion speciosum, Leidy. Upper teeth. Miocene.
Neohipparion affine, Leidy. Upper teeth. Miocene.
Neohipparion gratum, Leidy. Upper teeth. Miocene.
Neohipparion montezumæ, Leidy. Upper and lower teeth. Miocene.
Merychippus insignis, Leidy. Upper jaw. Miocene.
Protohippus (Merychippus) mirabilis., Leidy. Upper jaw. Miocene.
Protohippus perditsu, Leidy. Upper jaw. Miocene.
Protohippus supremus, Leidy. Upper teeth. Miocene.
Parahippus cognatus, Leidy. Milk teeth. Miocene.
Parahippus (Desmatipus) crenidens, Scott. Upper and lower jaws. Miocene.
Anchippus texanus, Leidy. Upper molar. Miocene.

Hypohippus affinis. Upper milk molar. Miocene.
Hypohippus (Anchitherium) equinus, Scott. Upper and lower jaw. Miocene.
Protohippus placidus, Leidy. Upper teeth. Miocene.
Mesohippus bairdi, Leidy. Skull and jaws. Oligocene.
Phenacodus primævus, Cope. Fore and hind feet. Eocene.

The photographs of mounted skeletons are of the following :—

Protorohippus venticolus, Cope. Eocene.
Cœnopus occidentalis, Leidy. Oligocene.
Protoceras celer, Marsh. Oligocene.
Oreodon culbertsoni, Leidy. Oligocene.
Hyænodon horridus, Leidy. Oligocene.

With photographs of restorations of :—

Protoceras. Six-horned upper Oligocene ruminant.
Elotherium. Giant upper Oligocene suilline.
Megacerops. Long-horned Lower Oligocene titanothere.
Hyracodon. Cursorial Oligocene rhinoceros.
Mastodon. Pleistocene elephant.
Dryptosaurus. Carnivorous Cretaceous dinosaur.
Agathaumas. Three-horned Cretaceous dinosaur.
Madrosaurus. Duck-billed Cretaceous dinosaur.
Siberian mammoth or hairy elephant.

Note on the age of the Horsefly, Similkameen and Tranquille Tertiary Beds of the Southern Interior of British Columbia.

Among the remains of fossil fishes in the Museum of this department are a number of specimens from Horsefly river, from the North Fork of the Similkameen river and from near Tranquille, Kamloops lake ; three widely separated localities in the southern interior of British Columbia. The recognition, lately, by the writer of a second specimen of *Amyzon brevipinne*, Cope, in the small collection from Horsefly river points to the probable synchronism of the sedimentary rocks in which the fossils at this locality occur with the Amyzon beds of Colorado and Nevada. The other fishes contained in the Horsefly River collection are referable to Cope's species *Amyzon commune*, characteristic of the Amyzon beds of Colorado.

The beds on the North fork of the Similkameen river from which remains of plants, insects and fish were obtained by Dr. George M. Dawson have, on the evidence of these fossils, been regarded as 'probably of Oligocene (later Eocene age)' (Dawson, Geol. Surv. of Canada, Annual Report, vol. vii, p. 76 B, 1895). The fish remains from this locality consist of the type of *Amyzon brevipinne* (on the evidence of which Cope correlated the Similkameen beds with the Amyzon beds of Colorado and Nevada*) and a fish scale, not hitherto noticed, which agrees in size and ornamentation with those of the specimens of *A. commune*, from Horsefly river.

* Proc. Acad. Nat. Sci. Philadel., vol. xlv, p. 401, 1894.

We thus have two species of Amyzon common to, and comprising the known fish fauna of the Horsefly and Similkameen beds.

Also it is probable that the beds near Tranquille belong to the same horizon as those of the Horsefly and Similkameen rivers as the fish remains from this first locality are apparently referable to *Amyzon commune.*

We may conclude, then, that the fish-bearing deposits of the above three localities are probably of the same age and synchronous with the Amyzon beds to the south of the International Boundary.

A description of the structure of *Amyzon brevipinne* based on the specimen of this species from Horsefly river will shortly appear in a paper by the writer.

The Botany and Climate of the Northwest Side of the Lower St. Lawrence

Professor John Macoun.

After my Summary Report for 1904 was written I continued to work on the Rocky Mountain flora and prepared a series of specimens for exhibition at Lake Louise, Field and Glacier in the Rocky and Selkirk mountains. An exhaustive work on the botany of the Rocky mountains, south of the International Boundary, is being prepared in the United States and as this is designed to include southeastern British Columbia and Alberta it has, meanwhile, been considered wiser to defer the completion of my report. The publication of Mr. A. O. Wheeler's work on the Selkirk mountains, for which I wrote a short account of the fauna and flora of those mountains, and the popular flora of the Rocky and Selkirk mountains by Mrs. Julia Henshaw, now in the press, so completely cover the ground in a popular sense that there is no urgent need of a more technical work.

Last spring you decided that, owing to our fragmentary knowledge of the flora and fauna of the St. Lawrence valley below Quebec, it might throw much light on the climatic conditions existing there if a study of its flora were undertaken. The only collections of plants we had from that region were those made by Dr. John Bell in 1862 and by the writer in 1882. Both collections came from the Gaspé peninsula.

Following out this decision, I left Ottawa on June 19th and made my headquarters at Montmorency Falls, extending my examinations to Quebec on the one hand and St. Joachim on the other. I worked here until July 12th, after which I made my headquarters at Cap à l'Aigle. From this point I examined the district west of Murray Bay and river and eastward to Port à Persis, which is some distance west of Tadousac. I remained here until August 31 reaching Ottawa on September 2. The season was very successful and large collections were made of plants of all kinds; at the same time the climatic conditions, and the many problems presented by the peculiarities observed were noticed. In making my collections I was assisted for the greater part of the time by Mr. Roy Cameron, of this city. A detailed report on the work done will be submitted as soon as possible.

After returning from the field I was occupied for two months making a collection of nearly 700 species of the fungi of the Ottawa district. Afterwards, collections made during the summer were carefully examined and presented many rare and interesting forms. The coldness of the water gave arctic sea-weeds, while the flora of the hill-sides indicated a summer temperature much higher than had been anticipated.

The arrangement of a Catalogue of the Mammals of the Dominion, on the same lines as that of the Bird Catalogue, has been commenced, and will be prosecuted steadily when other work will permit.

Botanical Work on the Southern Boundary of British Columbia.

Mr. J. M. Macoun.

Between the date of my Summary Report for 1904 and my departure for the field in May my time was occupied in the routine office work and in the determination of specimens collected by me and others during the previous season. The "Flora of the Hudson Bay region" was also completed and is now ready for the press.

Pursuant to your instructions I made arrangements to spend the collecting season of 1905 in British Columbia, in the vicinity of the International Boundary. Early in April my field assistant, Mr. W. Spreadborough, joined one of the survey parties at work in the vicinity of Midway, where I joined him later, and proceeded thence to Mr. Ogilvie's camp at Rock creek. From the end of May until the middle of August I either camped with him or was given supplies and transport by him, and every facility was afforded me for the successful prosecution of my work. After my arrival, Mr. Spreadborough's time was devoted chiefly to the collection under my direction of birds and mammals, while my own labours were given to botany. Following the old Dewdney trail, we crossed the country between Midway and the Skagit river, spending several weeks in the vicinity of Osooyos lake. Less was known of this region, from a natural history point of view, than of any other part of British Columbia, and several birds and small mammals not before collected in Canada were secured, as well as many new plants—some new to science, others not previously recognized in Canada.

The month of July and part of August was spent in the Skagit valley and on the mountains between the Skagit river and Chilliwack lake. These mountains were found to be the district in which several groups of small mammals intermingled. The flora was that characteristic of the mountains farther west but several new species of flowering plants were discovered. Leaving Mr. Spreadborough to complete the season's work I returned to Ottawa August 22nd and after working a few days in the office took advantage of the fine weather to study the aquatic plants in the streams near Ottawa. The collections made last September will, with our previous knowledge, enable us at any time to write a full report on these plants.

Since returning to the office I have been engaged in naming specimens sent in by collectors and in working up my own collections.

Office Work.

During the year 4,441 sheets of botanical specimens were sent to herbariums in different parts of the world, chiefly to government or university museums, in exchange for specimens received. These latter numbered more than 2,000. A larger number of specimens than usual were mounted and placed in our herbarium—4,799 in all.

Eight hundred and nineteen official letters were written and about the same number were received.

MAPPING AND ENGRAVING.

Mr. C.-O. Senécal, Geographer and Chief Draughtsman.

The following is a statement of the work carried out under the supervision of the Geographer and Chief Draughtsman during the past calendar year :—

Mr. L. N. Richard completed the plotting of the Nova Scotia traverse lines run in 1904 and laid out base-lines for sheets Nos. 84, 85, 88, 95, 96, 97, 98, 103 and 104 N.S.; he completed the map of Montreal and vicinity for engraving, revised the compilation of Ignace sheet (No. 5 N.W. Ont.) which he also prepared for engraving and lithographing.

Mr. Richard left for the field on the 24th of June, under instructions to run transit and chain traverse lines in Nova Scotia along the D. A. Ry. between Middleton and Digby, along the Caledonia Branch of the H. & S. W. Ry. and along the Liverpool road between Parkers cove on the Bay of Fundy to Liverpool bay on the Atlantic. About 200 miles of railway and road were surveyed, the plotting of which will be available as base-lines for the construction of Sheets Nos. 90 to 121. Mr. Richard is at present drawing a map of the shore-lines of the Ancient Great Lakes in Ontario for the Summary Report of the Department for the past year.

Mr. O. E. Prud'homme made additions to the Ottawa and Cornwall sheet (No. 120 Ont. and Que.), traced and lettered Pembroke sheet (No. 119 Ont.) Gay River and Musquodoboit Harbour sheets (Nos. 54 and 55 N.S.), for engraving, and prepared the copy for photolithographic reproduction of the maps of Nicola Valley Coal Fields, B.C., Yamaska mountain, Que. and Nictaux-Torbrook Iron district, N.S.

Mr. J. A. Robert calculated latitudes and departures of the traverses run in Nova Scotia in 1904 and part of those run in 1905. He revised the Nova Scotia sheets Nos. 59, 60, 61 and 62, and worked on the compilation of Mr. Fletcher's surveys on Sheets Nos. 83, 84, 85, 98, 99 and 103, which are at present fairly advanced. He compiled the maps of Nictaux-Torbrook district, N.S., and of Chibougamau region, Quebec, and traced the latter for engraving.

Mr. H. Lefebvre was appointed on the permanent staff and reported himself for duty on the 31st of January. He compiled and traced for engraving the Brome Mountain map and prepared the copy for photolithographic reproduction of the map of the Kluane Mining district, B.C. and of the West Coast of James bay. He assisted Mr.

D. B. Dowling in the compilation of that officer's phototopographic maps of the Cascade Coal Basin, Alberta, and traced the four following sheets of this map for engraving, viz.: (No. 1, Panther River sheet; No. 2, Cascade River sheet; No. 3, Canmore sheet, and No. 4, Wind Mountain sheet).

Mr. F. O'Farrell continued the compilation of Mr. E. R. Faribault's Nova Scotia surveys on the 1 mile scale. He compiled Sheets Nos. 70 to 73 incl.; revised Sheets Nos. 66 to 69, and commenced Sheets Nos. 86 to 89. During the summer Mr. O'Farrell accompanied Mr. Faribault in Nova Scotia and assisted this officer in the revision of his map work.

Mr. P. Frèreault completed the compilation and made the tracing for engraving of the map of Northeastern Canada on the scale of 50 miles to an inch, prepared the copy for photolithographic reproduction of the maps of Duncan creek, Yukon territory, Costigan Coal Field, Alberta, and nine diagrams to accompany various reports.

Mr. V. Perrin assisted Mr. Wm. McInnes in the mapping of his surveys of the Winisk river and attended to general work. He resigned in March.

Mr. A. Dickison has been employed on the temporary staff of this office since the 3rd of July. He reduced the published and unpublished geological surveys of Nova Scotia to the scales of 4 and 8 miles to 1 inch and constructed two maps to accompany a special report on Nova Scotia. The engraver's copy of these maps is nearing completion. He also traced and lettered a map of Yukon territory for the Summary Report, 1905.

Mr. J. J. McGee, jr., was employed as general assistant and typewriter. He attended to the classification of records and made sundry tracings for office and field use. He accompanied Mr. Richard last summer in the field as chainman.

The following maps were compiled by field officers from their respective surveys:—

The Yukon Territory (including a survey of Peel river by C. Camsell), scale 32 miles to 1 inch, Mr. J. Keele.

The Cascade Coal Basin, Alberta, scale 1 mile to 1 inch (4 sheets, Topographical and Geological editions), Mr. D. B. Dowling.

The Moose Mountain Region, Southern Alberta, scale 2 miles to 1 inch, Mr. D. D. Cairnes.

The Southwest Coast of Hudson Bay, scale 16 miles to 1 inch, Mr. O. O'Sullivan.

Progress work on 8 mile map of Northwestern Ontario, Messrs. W. J. Wilson, W. H. Collins.

Revision of Sheets Nos. 53, 54 and 55. Progress work on Sheets 66, 67, 72 and 73, Nova Scotia, scale 1 mile to 1 inch, Mr. E. R. Faribault.

The routine work of laying down geographical projections, making photographic reductions of maps, sun prints, tracings, list of repairs, etc., was divided among the staff and attended to.

The meetings of the Geographic Board were regularly attended as usual.

The following three maps accompany the Summary Report for the past year, viz. :—

No. 915. Southwest Coast of Hudson Bay, scale 16 miles to 1 inch.

No. 916. Windy Arm Mining District, B.C., scale 2 miles to 1 inch.

No. 917. Yukon Territory, scale 32 miles to 1 inch.

Besides the above mentioned maps, there are about twenty in the hands of the King's Printer at various stages of progress, including the copper plate editions of twelve sheets of the Nova Scotia systematic series on the scale of 1 mile to 1 inch, the last proofs of which have been revised and are ready for the press. It has been deemed advisable to hold over many of these sheets until the colours of the full set have been thoroughly revised and to have them printed together at one time in order to secure uniformity in the geological tints.

The edition of the following maps and diagrams was received from the King's Printer during the past calendar year :—

Catalogue number.	Description.	Area in square miles
885	Yukon Territory—Klondike District and Vicinity Showing Water Supply. Scale 8 miles to 1 inch	
886	Yukon Territory—Distribution of Auriferous Gravels in Klondike Mining District. Scale 2 miles to 1 inch	About 1,300
772	Yukon Territory—Geological Map of Klondike Mining District. Scale 2 miles to 1 inch	" 1,300
891	Yukon Territory—Duncan Creek Mining District. Scale 6 miles to 1 inch	
894	Yukon Territory—Sketch Map, Kluane Mining District. Scale 6 miles to 1 inch	" 2,500
834	British Columbia—Economic Minerals in Boundary Creek Mining District. Scale 1 mile to 1 inch	344
828	British Columbia—Geological Map, Boundary Creek Mining District. Scale 1 mile to 1 inch	344
890	British Columbia—Coal Basins of Nicola Valley. Scale 1 mile to 1 inch	
892	Alberta—Costigan Coal Field. Scale 4 miles to 1 inch	32
889	Keewatin—Sketch Map, Lac Seul to Severn lake. Scale 35 miles to 1 inch	
895	Ontario and Keewatin—West Coast of James Bay. Scale 16 miles to 1 inch	
898	Ontario—Sketch Map, Bruce Mines, Desbarats District	
770	Ontario—Geological Map of part of Hastings, Haliburton and Peterborough counties (Bancroft map). Scale 2 miles to 1 inch	2,000
708	Ontario—Haliburton Sheet, No. 118. Scale 4 miles to 1 inch	3.456
874	Quebec—Geological Map, and Section, Island of Montreal and Vicinity. Scale 4 miles to 1 inch	1,850
887	Quebec—Geological Map, Yamaska Mountain. Scale 20 chains to 1 inch	12
901	Quebec—Geological Map, Brome Mountain. Scale 40 chains to 1 inch	90
867	Nova Scotia—Wine Harbour Gold District. Scale 250 feet to 1 inch	
897	Nova Scotia—Nictaux-Torbrook Iron District. Scale 25 chains to 1 inch	
	Eight diagrams showing Mineral Production to 1903 inclusive	
	One diagram, Larose Mine, Ontario	

The number of letters, memoranda, specification sheets, &c., relating to map work was 220 sent and 175 received.

THE LIBRARY.

Dr. John Thorburn, Librarian.

During the year, from January 2nd to December 30th, 1905, there were distributed 13,861 publications of the Geological Survey, comprising reports, parts of reports, special reports and maps; of these 13,358 were distributed in Canada, the remainder, 503, in foreign countries, as exchanges to universities, scientific and literary institutions, and to individuals engaged in scientific pursuits. The reason why comparatively few publications were sent to foreign countries was because the Annual Report, Vol. XIV, has not yet been issued, although it has been in the printer's hands for several months.

The sale of publications during the year, including reports and maps, amounted to $663.19. As will be seen, the amount received has been gradually decreasing. This is owing to the fact that, for some years past, the free distribution has been on a more liberal scale than was the case previously.

There were received, as exchanges or donations to the library, 3,247 publications, including reports, transactions, proceedings, memoirs, periodicals and maps. The volumes purchased during the year were 715, and 54 scientific periodicals were subscribed for. The number of letters received in connexion with the library was 2,905, besides 1,536 acknowledgments from exchanges and individuals. The number of letters sent from the library was 2,664, besides 665 acknowledgments for publications received.

There are now in the library about 15,500 volumes, in addition to a large number of pamphlets on various subjects.

The number of volumes that were bound during the year was 385.

The library is open from 10 a.m to 4 p.m. for persons wishing to obtain information in regard to scientific subjects.

Mrs. J. Alexander is assistant librarian, and has charge of the cataloguing and shelf arrangement of the books.

Much of her time is occupied in supplying information to inquirers regarding survey publications and in assisting members of the staff to find literature bearing on the work in which they are engaged.

Miss Barry has charge of the distribution books and of the exchange lists, besides the acknowledgments received for publications sent out. She also has charge of the filing of letters relating to the work in the library. Apart from her duties in the library, Miss Barry keeps a record of the non-attendance of the permanent and temporary members of the survey staff.

During part of the day Miss Stewart typewrites the letters sent out having reference to the library. These are constantly increasing, as may be seen by comparing the numbers sent out for some years past.

Miss Alexander enters all publications received in the accession book, and attends to the indices. She acknowledges all publications received by presentation, and assists in typewriting.

STAFF, APPROPRIATION, EXPENDITURE AND CORRESPONDENCE.

The staff at présent employed numbers 67.

The funds available for the work and expenditure of the department during the fiscal year ending June 30, 1905, were :—

Details.		Grant.	Expenditure.
		$ cts.	$ cts.
Civil-list appropriation		63,075 00	
General appropriations		113,815 25	
Civil-list salaries			58,129 29
Explorations and surveys			27,529 22
Wages of temporary employees			26,860 47
Printing, engraving and lithographing			17,605 54
Books and instruments			5,430 78
Chemicals and apparatus			484 54
Specimens for Museum			6,589 10
Stationery, mapping materials, &c			2,169 57
Incidental and other expenses			3,565 93
Advances to explorers			40,065 96
			188,430 40
Less—Advanced in 1903-04 on account of 1904-05	$19,202 50		
Deduct—Unexpended advances credited Casual Revenue	855 07		
			18,347 43
			170,082 97
Unexpended balance Civil-list appropriation			4,945 71
" General "			1,861 57
		176,890 25	176,890 25

The correspondence of the department shows a total of 13,125 letters sent, and 13,904 received.

I have the honour to be, sir,

Your obedient servant,

ROBERT BELL,

Acting Deputy Head and Director.

OTTAWA, April, 1906.